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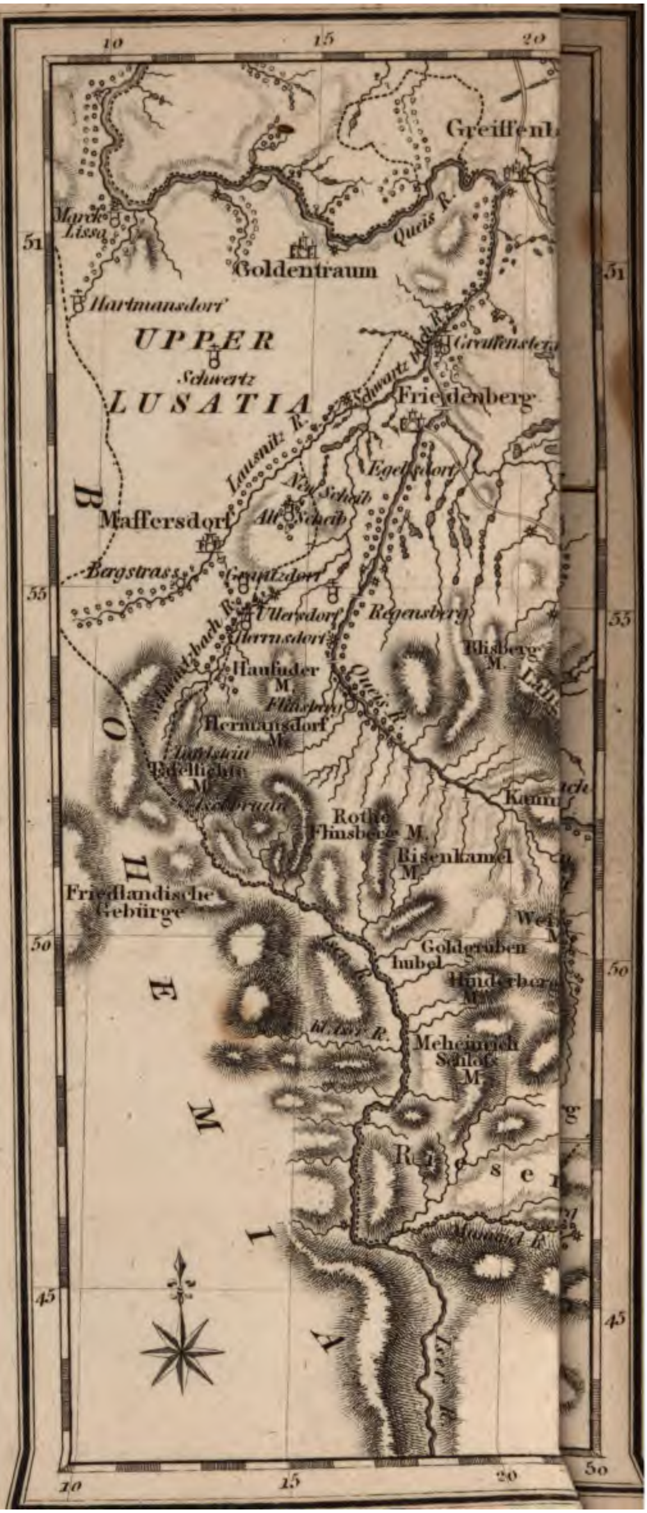
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EOLOGICAL TRAVELS

IN SOME PARTS OF

FRANCE, SWITZERLAND,

AND

GERMANY.

BY J. A. DE LUC, F.R.S.

IN TWO VOLUMES.
ILLUSTRATED WITH TWO TOPOGRAPHICAL MAPS.

RANSLATED FROM THE FRENCH MANUSCRIPT.

VOL. II.

LONDON:
PRINTED FOR F. C. AND J. RIVINGTON,
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By Law and Gilbert, St. John's Square, Clerkenwell.

1813.

TRAVELS

IN SOME PARTS OF

SWITZERLAND AND GERMANY.

JOURNEY *from* DRESDEN *through* LUSATIA, *to the* GIANT'S MOUNTAINS *in* SILESIA, *with the Return through* BOHEMIA *to* BERLIN.

454. I COMMUNICATED to Baron Von Racknitz my wish to ascend the *Elbe*, in order to observe its issue from the mountains of *Bohemia*, which I had intended to do in the course of my present journey to the *Giant's Mountains;* but he advised me rather to defer this part of my plan to a future opportunity; telling me that it would be well worth my while to go by land to observe the countries which on both sides border the *Elbe* from above *Pirna;* and that his friend Baron Von Block would with great pleasure accompany me in such an excursion. When this plan was proposed, it occurred to me that, from the right bank of the *Elbe*, I might proceed through *Lusatia* to the *Giant's Mountains;* and on my mentioning this idea to Baron Von Racknitz, he advised me to send on my own carriage,

with post-horses, to the place at which Baron Von Block was to leave me, when he returned towards *Dresden*, and to take another carriage for the present excursion: this was arranged accordingly, and M. Keuler desired to be of our party.

June 12*th*. 1798.—We set out from *Dresden* at seven in the morning, and proceeded up the left bank of the *Elbe*, but at some distance from the river. Half a league from the city, near the village of *Lockewitz*, we passed over hills composed of *strata* of *argillaceous stone-marl*, containing *marine bodies*. Farther on, we came to a hill of *granite*; and at *Maxen* we ascended others of *gneiss*, which do not however bear the softened forms of the *Freyberg* hills; for here a very wild appearance is given to the whole country by deep vallies, with abrupt sides, which are studded with sharp rocks interspersed with fir-trees. These are indeed the same *strata* of *gneiss* that extend to *Freyberg*; but *Maxen* is much nearer to the great *subsidence* which has produced the valley of the *Elbe*, and which, in the part nearest to the river, has been attended with many double fractures, where, as the intermediate masses have *subsided* to a much greater depth than the others, intervals have been left, on the sides of which the *strata* appear in great disorder, inclining various ways, with very picturesque projections. None of those narrow fissures, however, wherein *veins* have originated, have here been produced in the large masses.

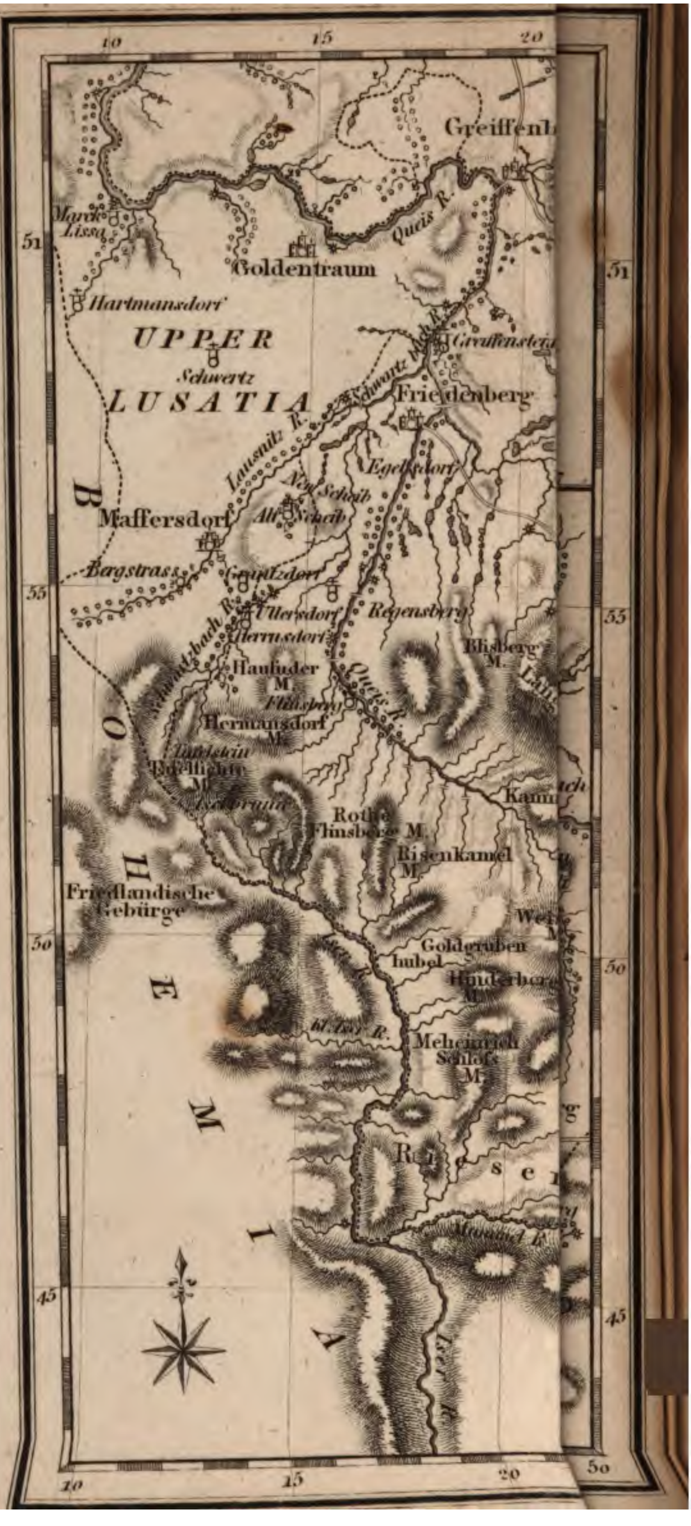
455. From many of the above large fractures have resulted only *combes*, which, descending from the higher parts of the hills, soon become of great depth: in these there cannot flow any streams but mere rivulets, formed by the springs that issue from the sides; and though in general the latter are so rugged, the bottom of these recesses has a very different character, being covered with meadows formed on the rubbish of *gneiss*, which has been spread and levelled by the rivulets, when swelled by great rains or melted snows. At a league's distance from *Maxen*, there are mills; the last of these is a saw-mill, situated on a brook; and near it I saw a very remarkable phenomenon, of which I had already been informed by Baron Von Racknitz. He had shewn me, in his cabinet, some very large specimens of the most beautiful agate, which had a white ground, with very regular angular stripes of red and violet, disposed in such a manner as to resemble plans of fortifications; and on my expressing some surprize at the size of the pieces, he had increased my astonishment by telling me that they were only fragments of a vein 20 feet in thickness, passing across the mountains in the part of the country which he had recommended to my observation. Baron Von Block knew very nearly the spot where this phenomenon was to be found; however, to save time in looking for it, we obtained a guide from the mills.

456. Having proceeded some way along a meadow bordering the mill-stream, we came to a part where

crossed by the *vein*, the section of which appears in a high abrupt rock on one of the sides, but is concealed on the other by a slope of rubbish covered with trees.

458. We had entered this valley through another, wherein flows the small river *Müglitz*, the waters of which were red, having been employed in washing the stamps of a tin-mine at *Altenberg;* and at half-past 3, we returned to the latter valley, by *Schmorsdorf.* At this point meet the lower parts of two combes; and on a large rock, left in an upright position by the catastrophe which produced them, stands the castle of *Wesenstein*, the rock itself forming a part of its walls. Having issued, by *Kötwitz*, from this low space, we crossed some hills composed of *strata* of *sand-stone;* and passing through the village of *Krebs*, we arrived on the bank of the *Elbe*, near *Pirna*. We here took a boat, in which we crossed the river, with our carriage, to *Coplitz*, on its right bank. Hence we ascended the hills, leaving the vale of *Liebthal* on our left, and advancing further inland, till, just as night was coming on, we arrived at *Lohmen*, a village which, like many others in *Lusatia* and *Silesia*, consists of an uninterrupted succession of cottages, each with its garden and its orchard, along the course of a little stream: some of these villages are several leagues in length.

June 13*th*. We set out from *Lohmen* at half-past 6 in the morning. Baron Von Block, who was our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the rains, and the grass continues to grow on it; so that the vallies themselves, whether wide or narrow, are so far from having been hollowed out by the waters which flow in them, that their bottom is really raised by this process. Each of these vallies is extremely unequal in breadth; the principal one, especially, contains some very wide spaces, while in other parts it is contracted into a mere defile: The projecting rocks here exhibit the situation of the *strata:* in the front of those which follow the direction of the valley, the lines marking their separations are nearly *horizontal;* but in some of these projections, they are seen, on the sides, to *incline* towards the valley, in others, towards different points; which indicates a difference in the angular movements undergone by the parts remaining at a higher level, at the epoch of that catastrophe of the *strata,* whence have resulted these interior vallies, which, as I have already shewn and shall continue to shew, assume so great a diversity of forms and directions, branching off from both the sides of the deepest and largest valley, namely, that which receives the *Elbe* at its issue out of *Bohemia;* in a future journey I shall describe the astonishing variety observable in the forms of this latter principal *valley,* as well as in the height of the mountains on its sides. My two companions, on viewing the objects before us, readily acquiesced in my opinion, that the *waters* flowing in these *vallies* had not had any share in their formation, which could only be ascribed to fractures, often double, through the whole mass of the *strata;* that the *widenings* and *contractions*

tions observable in the course of each *valley* had been occasioned by differences in the width of the masses *subsiding* in the intervals of these fractures; and that the various inclinations of the *strata* had arisen from the unequal *subsidence* of the masses remaining at a higher level on their sides.

462. At half-past 8, we arrived at *Wehlen*, a village on the borders of the *Elbe*. Here begin, on the right bank, those *precipitous rocks;* which, with no other interruption than a few fractures, extend a league up its course to the village of *Raden*, situated in a part where this river is joined by a brook. At *Wehlen* we hired a boat, in order to ascend the *Elbe* as high as the latter village; and the wind being favourable, and this part of the stream not very rapid, we soon accomplished our little voyage with the assistance of a sail. It is within this space that there are, on the right side, the principal quarries of that beautiful *sand-stone*, which is transported along the whole course of the *Elbe* by the name of *Pirna stone*, though *Pirna* itself is on the opposite bank of the river; but the same stone is found also near that town, and was probably first worked there, as being more easy of access. The quarries on the right bank being at a considerable height, their rubbish forms below them a long slope, which covers the sections of the inferior *strata*. When blocks are detached from the uncovered strata above, they are easily made to slide down this slope, to a platform of considerable breadth, which lies between it and the river, and on which they are hewn for their various uses, before

they are put on board the barges. In time, it will become necessary to clear away the upper part of this slope of rubbish; which will be no easy task, because the sections of the *strata* are already much covered by it. I went a little way up the slope, in order to examine whether these *strata* contained any *marine bodies;* I found on their fragments a great many impressions of large *pectines;* and my two companions told me that, in some parts, several other species were observed. Thus it is evident that these *strata*, which we now see *broken*, *inclined*, and partially *sunken*, must have been originally formed, like all others, in a *continuous* and nearly *horizontal* situation.

463. By these quarries, the whole front of this side of the *Elbe* on which they have been opened is rendered entirely bare: above the slopes of rubbish, it rises precipitously to the summit; and the slopes themselves are too incessantly accumulating to permit vegetation to overspread them. The top of the precipice is extremely picturesque, being deeply dissected into distinct rocks, of very irregular forms. It was here that I observed, for the first time, the phenomenon to which I have referred as explanatory of the *rounding* of the scattered *blocks*, while still remaining in their original places, by the decomposition of their *angles*. These distinct *rocks* on the brow of the precipice have acquired their present form in consequence of fractures, attended by the crumbling down of the parts that once occupied their intervals,

which has reduced them into a kind of columns, composed of insulated masses of the *strata:* now the uppermost masses having been most exposed to the actions of the air, especially of the winds, which have not in the same degree affected those below them, and these actions not having been equal on all their sides, it has hence resulted that most of the columns, when viewed from a distance, have the appearance of giants with deformed heads on monstrous bodies: the firs which have sprung up in the intervals of these rocks, and now encircle them, render their general aspect still more picturesque. On expressing to the Baron my wish to examine the ridge more nearly, he told me that to take me up to it from *Raden*, formed a part of his plan; and that we should afterwards descend from it into another valley, which would lead us to the place where he had appointed our postillion to wait for us with the carriage.

464. We reached *Raden* at half-past 10. I have already said that this village is situated at the point where a brook discharges itself into the *Elbe;* this small stream arrives through an opening in the rocks, extending inland a considerable way; and on its right advances a promontory, the continuation of the abrupt ridge in which are the quarries. We ascended the extremity of this promontory by a path at first very steep; and when we had reached its summit, I remarked a circumstance which I had afterwards frequent opportunities of observing in a journey towards

the higher part of the course of the *Elbe;* namely, that the abrupt sides turned towards the river are those, not of any wide hills, but of ridges of narrow hills, with angular summits only a few feet in breadth: there are here two ridges of this kind, which have been produced by fractures more or less parallel with each other, the angular motions of the strata having been directed towards deep vallies. The ridge nearest the river is that in which the quarries are; and the other is but a little behind it, being separated from it only by a vale of inconsiderable depth. This inner ridge slopes down rapidly, on the side farthest from the river, to a very deep *combe* descending towards *Raden;* the slope consists of rubbish, and is clothed with a fir wood. It was during the catastrophe which reduced these masses of strata to the form of ridges, that the narrowness of their summits occasioned them to split in so many places; and since the birth of the continent, the winds have widened their fissures, and given to their separated masses this columnar form; for the ridge within is in this respect perfectly similar to that which commands the *Elbe.* We entered the small vale dividing the two ridges, by an interval between the columns of that farthest from the river, the inner side of which we observed to be cut down vertically.

465. Having followed a very narrow path, bordered by a line of rocks, on the upper part of a small slope of rubbish rising up to the brow of the abrupt side next the *Elbe,* we arrived at the foot of one of

those

ch is said to be the most ancient edifice in the whole country. The *Canopy* is the uppermost *block* of such a pile as I have just described, and is of an oval lenticular form: several persons may stand together on the flattest part of it, if their heads are sufficiently strong not to turn, on seeing the *Elbe* flow many hundred feet below them.

468. What an extraordinary scene had we here within our view! On the opposite side of the *Elbe*, we saw immediately before us the summits of many hills terminating in sharp angles, and dissected into various forms, like that whereon we stood; and at a greater distance, we distinguished the summits of the hills of *gneiss*, separating the vallies or combes of *Maxen*, *Schmorsdorf*, and the *Müglitz*, through which we had passed the preceding day. Now when, on viewing these hills of *gneiss* rise above those of *sand-stone*, it is recollected how much greater *angular motions* have been undergone by the former strata than by the latter; when it is farther considered that these latter, which contain *marine bodies*, are of great thickness, and that consequently a very long time must have been required for their accumulation on an extensive tract of the bed of the ancient sea, a very lively idea may be formed of the revolutions to which that bed must have been exposed, after the *strata* of *gneiss*, already fractured, were covered by these new *strata*; a great part of the mass of all the strata having undergone, during the latest of these revolutions, the *subsidence* whence resulted the deep

valley of the *Elbe*, towards which the *strata* of *sand-stone* slid down over those of *gneiss*, breaking into several ridges, as has been seen in the small lateral vallies.

469. If any farther proof were required that the valley of the *Elbe* has not been excavated by the river itself, this proof might here be afforded by the appearance of its opposite bank, which is very low, and much intersected. For all *action* requires a *reaction;* so that it could not have been possible for a river with a strait course, like the *Elbe* in this part, to cut down its bank precipitously on the right side, unless it had had a support, from the top, on the opposite side. Now if the level of this river had been, perhaps not more than 10 or 15 fathom, higher than at present, it would have extended its waters, through several openings, over a very wide tract of country, in which, losing its rapidity, it would have formed lakes. Many openings of this kind will be seen on both sides of the *Elbe*, towards the upper part of its course; where it is every where equally evident that this river has merely followed a channel which it found already open when it first began to flow.

470. The whole of the country, which lay within our view from the *Canopy*, appeared very evidently to have been a scene of great catastrophes, from the multitude of pyramidal mountains, not only in the tract composed of strata of *sand-stone*, but in that consisting of *primordial strata*. In the first of these

tracts there were some very remarkable eminences rising to a great height above others of a similar kind, which had subsided. The *strata* that form these pyramids contain *marine bodies*, and must consequently have been originally *continuous*, and nearly *horizontal*, at the highest level which they now attain. It would therefore be desirable to bring hither those who persist in imagining that the *pyramids* in the *Alps* are a kind of large *crystals*, formed on the bottom of the sea, in the same manner as those are, which we see rise on the bottom of the vessels wherein *salts* are made to *crystallize;* when these persons beheld similar *pyramids* composed of *strata* that contain *marine bodies*, they would surely understand the real cause of all eminences in this form; namely, that, during the *subsidence* of the whole mass of the *strata*, some parts were left at a higher level, having found supports beneath, in the *caverns* into which the rest of the mass then *sunk*. Of the large *pyramids* here within our view, the most distant, on the right bank, was the *Zirkel-stein;* and nearer to us, on the same bank, rose the *Lilien-stein*. On the left bank was the famous *Königs-stein*, with its summit crowned by a fortress; and behind this we saw many similar eminences, among which were the *Pfaffen-stein* and the *Quell*. I shall give a farther description of these pyramids in a subsequent journey, when I had a nearer view of them.

471. After we had observed the commencement of this country of *pyramids*, which extend into *Bohemia*,

mia, we came down from the *Canopy;* and passing through its gate-way, and through one of the openings in the parallel ridge of eminences behind, we descended the wood on the opposite side by a very steep path, down to the bottom of the above-mentioned *combe*, where the soil, being levelled by the sand washed down from the slopes, is now covered with grass. We went up the *combe*, till we came to the foot of an amphitheatre of high rocks, which terminate it, at the higher end, and which shew very evidently that all these hollows, whether *combes* or *vallies*, are merely the effect of *subsidences*. As there was here no passage, we returned down the *combe*, to a low space called *Raden-grund*, in which several vallies meet in a kind of half-star; and the rivulets issuing from them unite to form the brook that passes through *Raden* to join the *Elbe*. We ascended the course of the largest of these streams, through a valley, the bottom of which is, to a great extent, horizontal, and covered with grass; and when we had advanced a certain way, we fancied ourselves in another cul-de-sac, on account of the large rocks which rose before us. But the Baron, who was acquainted with the spot, led us up a path obliquely ascending the slope of rubbish on our right; and this brought us to the entrance of a chasm, which is at a considerable height in the rocks above, and winding through them for a long way, with an insensible rise, at last opens into the elevated plain whence we had descended into the first of the *systems of vallies*, which I have described as arriving separately in the great *valley* of the *Elbe:* but at the point where this chasm opens into the plain, it is less abrupt than that which had first afforded us a passage. The brook that flows in the *combe* descends through this defile, where it forms a *cascade*, as I shall presently describe, and then rushes down the *slope of rubbish* which we had ascended to gain the entrance of the chasm from below; when, swelled by great rains, the stream has made furrows in this slope, carrying down the rubbish, and spreading it over the horizontal part of the bottom of the combe, on which it has accumulated; and below this point, the waters no longer propel any thing but sand along their course. This is one of the very numerous operations which are carried on in the vallies belonging to mountains, and of which the *origin*, the *progress*, and the *limits*, are all within our observation.

472. It is a little within the entrance of the chasm from below, and at a point where it suddenly becomes deeper, that the brook falls in a *cascade*, from the top of a rock in which there is a *grotto*. The brow of the rock being horizontal, the brook here spreads to a greater width, and rushes down in a fine sheet of water; but we passed behind it without being wetted, and entered the *grotto*, which we found lined with various ferns and mosses. The Baron told us, that, at the moment when the rays of the sun fall on the sheet of water, those who are in the *grotto* behold the most beautiful assemblage of prismatic colours; an effect resulting from the different

refractions of the rays produced by the small rills into which the cascade is divided. I must here say a few words generally, respecting *grottoes* and *cascades.*

473. *Grottoes* and *caverns* constitute one of the effects of those catastrophes which the *strata* have undergone; the cause of their production is that, during the *subsidence* of the already fractured mass, some of the pieces, finding beneath them larger *vacancies* than the rest, and consequently *sinking* to a greater depth, left above them *cavities*, either interior or exterior, in some places under the plane of the superior *strata* still remaining continuous; in others, between large fragments which fell in such a manner as to support each other archwise. As for the *cascades*, so frequent among mountains, they are to be considered, not only as effects of the catastrophes which had produced those abrupt sections of the rocks here occurring in the course of the streams, but as belonging to the number of the proofs that *vallies* have not been *excavated* by *running waters.* Some *streams*, after having flowed uninterruptedly in a high *valley*, suddenly arrive at one of these abrupt sections of greater or less depth, and precipitating themselves from the top, they are thus brought to a lower level, where it is evident that they can never have had power to act. It would have been easier for them to cut the brow of the rock over which they pass thus rapidly, than to hollow out a continuous bed; but this brow, on the contrary, affords a proof

that they do not *excavate* any where, since it is in general covered with moss; the growth of that plant being favoured by the air, to which the sheet of water, becoming thinner proportionally to its increase in rapidity, affords access on its bed. Such is the case on the border of the *cascade* in this defile; and other examples of it will appear in the sequel of my journey.

474. Ascending one of the sides of the cascade, we proceeded by a narrow cleft in the rocks, through which the brook arrives, and of which the slope is such, that the stream is enabled, by artificial means, to turn several mill-wheels in its course. At the upper end of this cleft, which opens into a ground higher than the summits of the steep ridges separating the lower vallies, stands the village of *Radenwalda*, or *Radewald*, where our carriage was waiting for us. From this point we continued for some time to ascend, till we reached the highest part, whence looking back towards the *Elbe*, we had a prospect which conveyed a very exact idea, though on a small scale, of an extensive tract in *Tartary*, described by travellers as above the level of the summits of some lofty mountains, the vallies of which are entered on descending from it; and the cause of this very plainly appears in the spot whereof I am now speaking. For here we looked down on many lines of the rocks forming the dissected summits of the abrupt hills, between which we had found *vallies* manifestly produced by fractures, with partial subsidences, and

angular motions of the separated pieces; these indeed being the general cause of the formation of *ridges* of *mountains*, which are composed of *strata* originally horizontal and continuous, and are separated by *vallies*, in consequence only of the greater *subsidence* of some of their parts, and the *angular motions* of those remaining at a higher level than the rest, though lower than that which these masses occupied in their original situation; as appears both here and on the high ground in *Tartary*. Many rows of fir-trees, one behind another, on the higher part of the course of the *Elbe* on this same right bank, led us to judge that catastrophes of a similar nature had there extended much farther than in the part which we had now observed.

475. Hence we proceeded towards the castle of *Stolpen*, built on a conical eminence, of which, however, the summit was not higher than the ground whereon we were travelling. In this road the *granite* appeared very near the surface, and we could even distinguish its *strata* in some parts, where the road was cut in it. Thus we had passed from the *strata* of *sand-stone* to those of *granite*, without perceiving the transition; the hills being covered with a very thick loose soil. These *granitic* strata are the continuation (though, as they have subsided, at a lower level) of those that form the chain to which the *Borsberg* belongs: I have already described that eminence, and we here had it on our left.

476. We now descended into a vale, from the bottom of which rises the mount whereon stands the castle of *Stolpen;* the base and the slope of this mount are covered with grass, except in parts where there are projecting rocks; and the castle is built on those of the summit, which we found to consist of a great mass of *prismatic basalts*, not large, and loosely arranged in groups; so that the rain water penetrating between them, their surface was become greyish by decomposition. It is remarkable that, at the foot of this cone, on both sides, we saw rising above the grass some small rocks, which, though of the same stone and much shattered, had so little regularity in their fractures, that, in another situation, they could never have been taken for basalts. I have met with this circumstance in several other places; I mean the association of regular *basalts*, with the same basaltic substance irregularly fractured. I shall have frequent occasions to mention *basalts* in the sequel of these Travels; but I shall mostly confine myself to a description of phenomena. For, in places where *basalts* are not accompanied with *porous lavas, scoriæ, volcanic ashes*, or *pumice-stones*, as they are in the volcanic mountains of the country of *Treves*, and in some of those of *Hesse*, it is very difficult to decide the general problem with any certainty.

477. In the road from hence to *Schmidtfeld*, where we arrived at 6 o'clock, we saw *blocks* of *granite* in the loose soil. Here I found my own carriage, which had been sent on from *Dresden;* and I took leave,

with much regret, of my two friendly and intelligent companions, who were this evening to return to *Dresden*, whence we were only at the distance of 3 miles and a half, while I was to continue my journey towards *Lusatia*. The weather being fine, I determined to travel all night, that I might the sooner reach the great objects which I had in view. At half past 7, therefore, I set out for *Bautzen*, distant 3 miles and a half, and arrived at that place at half after 1 in the morning. My road lay through woods and arable lands, interspersed with several villages and towns; the soil is of *sand;* and in several places I saw in it great accumulations of *blocks*, some of which were very large.

June 14*th*. I set out from *Bautzen*, at three quarters after 4, for *Löbau*, which is at the distance of 3 miles, and where I arrived at half past 8. For some way, I saw *granite* occasionally at the surface; but afterwards it disappeared, even where deep intersections were made in the *sand*, the upper part of which contained abundance of *granitic blocks*. As I proceeded, I found the country become more hilly, and some of the hills had abrupt sides. I saw among them several large insulated eminences, rising with a sharp summit, and sloping down all round to the general level of the soil: the tops of these were covered with firs, and their slopes were cultivated. On an attentive study of the country, it is manifest that these are *eminences*, only because other masses of *strata* have *subsided* around them: I had reason for supposing them to consist of *granite*; but I had not a near view of any of them; I saw a chain of more continuous mountains at some distance on the left. As I approached *Löbau*, I observed that the road was paved with *basalts*.

478. From this place I set out, at a quarter after 9, for *Herrnhütte*, a mile and a quarter distant, and arrived there at a 11 o'clock, having travelled over a very good causeway, almost entirely paved with *basalts*. The hills, which are very numerous, become here narrower and more rapid. The soil is *sandy*, and is seen, in the intersections, to be very deep; but in some places I observed the *granite* rising above it, and there are everywhere *granitic blocks* on the surface. I ascended the last hill on my road through a wood of firs and birches, where the soil was very stony, being full of fragments of *granite*. As this hill is of considerable height, its summit commands a view of an extensive vale, with several eminences rising in it, on one of which is *Herrnhutte*, where I spent this and the following day.

479. This is the principal settlement of the *Moravians*, or *United Brethren*, for whom I entertain much esteem; as I expressed in my first Travels, where I described another of their settlements at *Neu-wied*. I had here the satisfaction of seeing Baron Von Watteville, the chief head of the Society, with the Baroness, his wife, daughter and heiress of Count Von Zenzendorff, who had esta-

blished this brotherhood under its present form, and had presented to it this town as a central place, convenient for the residence of the Directors, who compose the body of Elders. I saw here likewise some of the chief of the Moravian Clergy, who were very respectable men: among these were M. J. LORETZ, of the country of the *Grisons*, and M. JEROME RISLER, who had both belonged to the society from the period of its first establishment at this place; M. DUVERNOIS, of the country of *Monbelliard*, where the brethren have another of their chief settlements; and M. HÜFFEL, secretary to the counsel of Elders, who kindly engaged to accompany me the next day to view the adjacent country.

June 15*th*. M. Hüffel conducted me to an insulated eminence, which is called the *Spitzberg*, or pointed mountain, and is at a league's distance from *Herrnhutte*, near *Hennersdorf*, on the S. E. of that town. The *Spitzberg* is the highest of two hills rising from one common base, which is covered with *granitic* and *basaltic* rubbish, and ascends with a gentle slope to the foot of these eminences. From this point, we proceeded up a more rapid slope to the top of the *Spitzberg*. Its summit is a rock composed of *basaltic prisms*, which are inclined, and present their sections on the outer side of the hill; they split, and a *talus* has been formed by their fragments; but it is not yet overspread with vegetation, because of the continual falls of fresh rubbish from the rock above. Hence it is manifest that this operation, though it must have commenced at the birth of the continents, cannot have continued through a very great number of ages.

480. We descended the *Spitzberg* on the inner side, or that next the small eminence. Of the *Spitzberg* itself, the slope was covered a considerable way down with *basaltic* rubbish; but, on entering a cultivated space at its foot, about 300 paces in breadth, we saw there nothing but *granitic* rubbish; till, reaching the foot of the small eminence, we found it bordered with a little ridge of *basaltic balls*, which were about a foot in diameter, and appeared to have rolled down from the summit. To this we ascended, in order to discover the origin of these balls; and it proved to be very singular. The rock was a congeries of spherical masses, 5 or 6 feet in diameter; and the interior part of several of these spheres, which rose above the general surface of the rock, being discovered by the decomposition of the external crust, we saw that they were composed of several distinct coats, within the innermost of which such *balls* as we had observed at the bottom of the slope were lodged, like the seeds in a pomegranate. We found *cups*, formed by the lower part of the coating of these spheres, which contained many of the smaller *balls*. In places where the rock was uncovered, we could perceive the points of contact of some of the large spheres, which seemed to have been produced by decomposition in a mass naturally continuous. How singular are these properties in stony bodies!

481. While we were still on the *Spitzberg*, the circuit of the horizon had struck me as a very interesting *panorama;* and M. Hüffel had pointed out and described to me the principal objects within our view. When we looked towards *Herrnhutte*, this horizon was bounded by the hills that I had crossed in my way from *Löbau;* but beyond these appeared a summit called *Solanderberg*, towards the extremity of which, on the right, rose a *basaltic* eminence named the *Rolestein*. On turning to our right, we saw another insulated eminence, bearing the name of *Spitzberg*, like that on which we stood, and having on its summit a similar rock composed of prismatic *basalts;* and behind this we perceived a chain of distant mountains. Continuing to turn in the same direction, we saw three conical eminences, of which the middle one was the *Landskrone*, near *Görlitz;* this eminence is *basaltic*, and very high; that on the left is also of *basalt*, but that on the right is of *granite*. After we had thus viewed half the circle of the horizon, we turned towards the extremity of a chain of mountains belonging to *Lusatia;* this extremity is called *Friedlandische-gebürge*, being near the town of *Friedland*, in *Bohemia;* some of its eminences are very high, and through an opening in them, we perceived some summits belonging to the chain of the *Riesen-gebürge*, or *Giant's mountains;* the rest of the circuit was occupied by another chain, the summits of which constitute the boundary between *Lusatia* and *Bohemia*. All these chains are composed of *granite* and *gneiss*.

482. Within the space encompassed by this elevated horizon rise several hills, many of which are of *basalt*, others of *granite*, and a few of *corneous schistus*. That whereon *Herrnhutte* stands is of granite; I walked round it with M. Hüffel, who led me first to a quarry, in which the *strata* of the *granite* separated the more easily, because they were strongly inclined forwards: he made me remark that this rock had on one side been covered with a *stratum* of *basaltic balls*, which followed the inclination of the *granitic strata*. Most of these *balls* having been cleared away, none remained but in the lower part, where the stratum passed under the loose soil at the foot of the hill. Continuing our walk, we came to a brook, which flows in the interval between this hill and the next. This interval is a very pleasant vale; paths have been made in it on the sides of the brook, and alleys have been cut through a wood descending to it, benches being placed at certain distances along the alley leading to the summit of the hill, on the opposite extremity of which *Herrnhutte* is situated; this *highest* part, where the inhabitants have a very pretty walk, commands a fine prospect. I saw in the vale a great many *blocks* of *granite;* these might be supposed to have fallen from the sides, if there were not among them some of *white quartz*, no *strata* of which externally appear.

483. Here then we have an assemblage of great monuments of successive catastrophes, wherein *strata* of various kinds, certainly formed one on another,

have been overturned beside each other, and covered with heaps of fragments, which are too widely dispersed to have been produced on the continent since it has existed; for that no cause can have detached them, and brought them down from the heights, appears very manifestly on considering the lowness of the neighbouring hills, the small quantity of water that descends from them, and the prodigious abundance in which these fragments are found: they must therefore have been ejected from within by explosions of the *expansible fluids* violently compressed in the caverns that received the vast masses of strata, which have disappeared externally, and from the subsidence of which have resulted the vacancies between the *hills* and *mountains* now existing; the latter being only the ruinous remains of those *strata* left at a higher level. The fragments produced during these catastrophes were triturated and dispersed by the agitation of the water on the bed of the ancient sea; and the sunken strata having also been covered with new *precipitations* of *sand* and other loose substances, a veil has thus been thrown over their state, which is consequently only discoverable in caverns and in mines.

June 16*th.* I set out from *Herrnhutte* at 5 in the morning, and went first to *Reibersdorf*, the seat of Count VON EINSIEDEL; knowing that he and the Countess, very respectable people with whom I had had the good fortune to become acquainted in London some years before, were at present residing at this place. In the road, I continued to observe the same varieties in the nature of the eminences separated from the chains of mountains, some being of *granite*, some of *basalts*, and others of *schistus;* while the soil of the adjacent fields was mingled with fragments of all these different stones. As I approached, at *Zittau*, the chain of mountains over which lies the road into *Bohemia*, I again observed *strata* of the same *sand-stone* as on the borders of the *Elbe*, containing the same *marine bodies*. I have already remarked that these *strata*, composing a mass of such great thickness, must necessarily have been formed, within a certain period, over all that part of the bed of the ancient sea, on which, at present, portions of them are found; those at *Zittau*, therefore, have been separated from the greater mass along the *Elbe* by subsidences and angular motions, which have brought to view externally the *strata* whereon those of *sand-stone* were originally deposited.

484. At half past 9, I arrived at *Reibersdorf*, where I met with a most obliging reception from the Count and Countess, who pressed me to make some stay with them. But I could not allow myself that satisfaction, on account of the length of the journey in which I was engaged, being well aware that its objects would require very particular attention; moreover, before I began my observations in the *Giant's Mountains*, where I was principally to seek for the phenomena to which M. Meierotto had referred me as supporting his system, I was to receive direc-

tions from a gentleman to whom he had given me a letter, Baron VON GERSDORF, who was then at his seat at *Mäffersdorf*, situated at the entrance of those mountains. I set out from *Reibersdorf* therefore at 3 o'clock, in order to reach *Mäffersdorf* the same evening.

485. In the fields, I again saw fragments of *basalts* mingled with those of *granite.* I passed through *Friedland*, the castle of which is built on a *basaltic* eminence. This town, and that of *Neustadt*, where I afterwards arrived, are on a slip of land belonging to *Bohemia.* From hence to *Bergstrass*, I found *granite* become more and more prevalent among the stones scattered in the fields; and there were some immense *blocks* of it, as well as of *white quartz*, though several ridges of hills still intervened between these grounds and the *granitic* mountains.

486. It was 6 in the evening when I arrived at *Mäffersdorf*, where Baron Von Gersdorf, to whom I was as yet a stranger, received me with that hospitality which particularly characterizes gentlemen, who, after having spent the early part of their lives in general society, have retired to their own estates, where they chiefly reside, continuing to exercise their minds in liberal pursuits. The Baron had studied several branches of natural philosophy and natural history, which soon supplied us with many common subjects of conversation. Among his instruments

of experimental philosophy, were some electrical apparatuses, most admirably constructed, and of great size. Aërial electricity had, in particular, been the object of his very assiduous pursuit, by means of an *electrical kite*, the string of which, composed of metallic threads intertwined with hempen, was more than 1000 feet in length. When the *kite* was raised, this cord was put in communication with an insulated *conductor*, which was solidly fixed near a window, and near which another *conductor*, in communication with the ground, might be brought by means of an insulating handle; and thus, without any danger, sparks might be drawn during a thunder-storm; the Baron told me that he had sometimes drawn them at the distance of two feet. The course of his very interesting and instructive observations relative to this object has been published, with the description of his apparatus, in the Memoirs of the *Society of Investigators of Nature at Berlin*. The changes in the elevation of the *kite*, occasioned by those in the force of the wind, are here seen to produce sudden transitions from the *positive* to the *negative* state, and *vice versâ*, which are indicated by the electroscope, and of which I have explained the cause in a paper presented to the same society. These are not changes in the *quantity* of *electric fluid* contained in the whole apparatus of the *kite*, but removals of the *fluid* itself from the *kite* to the bottom of its *string*, or from the latter to the former, occasioned by the influence of the various *electric* states of the *strata* of the atmosphere attained by the *kite:* an effect similar to that which is produced on a long insulated *conductor,* when a body, whether *positive* or *negative,* is approximated to either of its extremities.

487. The *lithological* collection of Baron Von Gersdorf was immense, and the specimens being very large, it was, on that account, the more instructive: he had, in particular, taken pains to collect all the genera and species of stones disseminated in the sandy plains of the country. There being a great variety of these, as is the case in many places, and some of them being very beautiful, I asked him whether the same *stones* were found in *strata* in the neighbouring mountains; he replied that they were not, and that this had always very much surprized him. Here then appears a new example of the great geological fact, that the *blocks* scattered at the foot of the mountains differ, as much as those observed in very distant *plains,* from the strata which compose these *mountains;* whence it is evident that the latter cannot have been the source of the *stony masses* disseminated in the *plains.* The Baron's collection contained also many species of *flints,* which had been found among other stones in the same *sand,* and of which some were of so bright a red, that, had they been cut, they might have been taken for *carnelians:* yet, in the whole country, there were no *strata* of *chalk,* nor any other kind of *calcareous strata* containing *silices;* and this affords a new proof of the cause which I have assigned to the dis-

semination of so many *silices* on the surface of our continents, namely, the *dissolution*, at a certain epoch, under the liquid of the ancient sea, of the *calcareous strata* in which they were originally formed. Lastly, in this *sand* the Baron had likewise found pieces of *yellow amber*. That resinous substance is found also in *Brandeburg*, *Mecklenburg*, and other *sandy* countries in the north of *Germany*; but its origin is still a mystery; because the tree of which it was the product no longer exists. We know that, at the moment when it issued in a soft state from the bark of this tree, it frequently enclosed within it insects of several species. It is on the sandy strands bordering the *Baltic* and the *North Sea*, that *amber* is collected in the greatest abundance; not that any is now formed on these strands, but that, having been contained in the sand of the cliffs, when this *sand* crumbled down, and was washed away by the waves, the masses of the *amber* were left on the surface, like other gravel. Amber is likewise found near brooks in the interior part of the country, because there also the sand contains it.

488. M. Meierotto had requested the Baron to give me such directions at my entrance into the *Giant's mountains*, as might enable me to go, by the straitest roads, to the parts which he wished me to observe; and first to *Schriebers-hau*, where I was to obtain farther instructions. The Baron advised me to proceed to that place on foot across the mountains; but first to visit a mountain in his own neighbourhood,

bourhood, called the *Tafelfichte*, (table of firs,) or *Tafelstein*, (table rock;) to which purpose he wished me to devote the following day. He rendered this excursion the more agreeable to me, by proposing to M. Ulrich and M. Hermes, two young friends of his who were then at his house, that they should accompany me in it; and they very readily agreed to be also my guides to *Schriebers-hau*, but we were prevented by bad weather from accomplishing the latter part of our plan.

June 17*th.* We set out from *Mäffersdorf* at 5 in the morning, accompanied by a man who carried provisions for our dinner on the great *table*. At first we returned back on the road by which I had arrived at *Mäffersdorf*, as far as *Bergstrass* and *Ober-gräntzdorf*, whence we began to ascend a first ridge of mountains, called the *Dreslerberg*, cloathed with a forest, on rubbish of *micaceous schistus* and of *quartz*. On the highest part, we found some rocks of these stones; but they appear very clearly not to have been the source of the rubbish which covers the large summit and the gentle slopes of the mountain. These rocks were left at their present high level, when the rest of the *strata* subsided around them; and it was during this catastrophe that they were overspread with the rubbish of the latter. The *strata* of these rocks appear at the summit of a cone formed by their own fallen materials, which it is very easy to distinguish from the rubbish that covers the rest of the mountain. These *strata* are strongly *in-*

clined towards the outer side of the mountain, and their section is at the top of the cone.

489. Hence we descended into a vale of little depth, beyond which rises the *Tafelfichte*, a high mountain, with a gentle slope covered with angular *blocks* of *granite;* some firs were growing among these blocks, but they were very young, because, a few years before, a violent hurricane had stripped this whole side of the mountain of the forest that covered it. At 7 o'clock we arrived at the entrance of the woods which had escaped this destruction, where we were glad to have recourse to our basket of provisions; and at 8 we reached a hut erected by Baron Von Gersdorf on the summit of the mountain, for the purpose of affording shelter to those who make this excursion, while at the same time they may enjoy from it a view of the prospect. This hut was placed on the most elevated part of a very extensive summit, from which the mountain has a gradual descent all around, without any rocks. Two chains of mountains, enclosing between them the part of *Silesia* called the Principality of *Jauer*, here meet and unite, forming a rounded angle, in the interval of which rises the *Tafelfichte*. One of these chains, extending to the N. W. of this spot, separates *Silesia* from *Lusatia;* the other, stretching S. by E. divides it from *Bohemia:* the latter chain is that of the *Riesen-gebürge*, or *Giant's mountains*, here beginning by the mountains of *Friedland* which belong to *Bohemia*, and separated from the *Tafel-*

fichte by a valley. The nearest summit of the other chain is the *Hau-fuder*, separated likewise from the *Tafelfichte* by a deep valley, in which flows a small stream called the *Schwartzbach*. On the slope of the *Tafelfichte* towards this stream, there is a *stone*, marking the limits of *Silesia* and *Bohemia*; and as a slip of *Upper Lusatia* terminates at the same point, all these three countries may be successively entered by only walking round this stone.

490. While I was on the *Tafelfichte*, I could judge, from a map of the country which I had in my hand, that my view extended first over *Upper Lusatia*, and afterwards, as I walked to the right, all around the summit of the mountain, over the county of *Glatz*, *Moravia*, *Bohemia*, *Misnia*, and the *Upper Palatinate*. The whole of this vast space had the appearance of an agitated sea; for it presented nothing but *chains of mountains* rising behind each other, as far as the eye could reach. The summit itself, thus insulated and without rocks, is entirely covered with *blocks* of a whitish *granite* containing very little *mica*, which is not liable to decomposition from the air; these *blocks* are consequently angular; and as they lie on a soil of little depth, the firs that grow here merely throw out their roots under and between them; hence this part of the forest was easily torn up and swept away by the above-mentioned hurricane. In this same country, I shall have occasion to describe a *granitic* mountain, the *strata* of which having undergone an angular movement,

the sections of those of various species of *granite* appear at the summit: some of the strata are of this whitish kind with little *mica*, and the *blocks* composed of them are angular, not having suffered any decomposition; these *strata*, however, are separated by others, which are easily decomposed; and the *blocks* of the latter are rounded, but not in consequence of being rolled, for they are on the very summit of the mountain, where they lie on a great depth of sand, produced by the decomposition of *granite* of the same species. This is a subject to which I shall return in the sequel.

491. In our way back to *Mäffersdorf*, we descended from the *Tafelfichte* on the side fronting the mountain of *Hau-Juder*. On this side of the former eminence, the planes of the strata under the loose soil are certainly parallel to the slope, and thus prevent the rain waters from penetrating beneath this soil. The humidity occasioned by this circumstance produces here a very thick moss covered with bilberry plants, in which the *blocks* scattered on the slope are almost buried; so that the descent would be very dangerous, had not paths been traced out; and these paths must be carefully followed. Between the blocks, there gush out several springs, forming rills, which are perfectly limpid, being produced by the water thus retained on the surface of the *granitic strata*. Among these little streams, that which descends from the highest point is called the *Iser-brunn*, or source of the *Iser*, a small river composed

of a vast number of rivulets flowing in the inflexions of the slopes, and uniting at the bottom of a valley, where the size of the stream increases as it receives the contributions of a greater extent of slopes: for some way, it forms the boundary between *Silesia* and *Bohemia;* then, entering the latter country, it soon unites with the *Elbe* in the upper part of its course, and might indeed as properly be called the *source* of that river, as the stream which is now so entitled. Continuing to descend this slope, we found, towards the bottom, a change in the nature of the *granite,* the masses scattered on the soil being as much rounded as those that we afterwards saw on the bed of the *Schwartzbach;* at which when we arrived, we returned to *Mäffersdorf* along its banks.

June 18*th.* Our schemes for this day were defeated by the rain. It was no longer possible to think of walking over the mountains to *Schreibershau,* because they are covered with high heath and bilberries, through which there is no path; so that we must have been wetted up to the knees at every step. I could not, therefore, follow my original plan, nor could I even set out this morning by the common road; for rain renders observation difficult as well as disagreeable. However, it made me some amends that I enjoyed more of the company of Baron Von Gersdorf; and the rain having ceased, he was so good as to accompany me himself to *Flinsberg,* a place much frequented on account of a spring of mineral water. But before I detail what we observed on our road, I ought to explain the object to which these observations referred.

492. M. Meierotto's principal motive for sending me to this part of the mountains of *Silesia* had been that I might observe, in the way from *Schreibershau*, a succession of *streams*, beginning with the *Kockel* and the *Zackel*, which flow together to join the *Bober*, and on the course of which he had assured me that I should find evident signs of ruptures of the *dikes* of *elevated seas*, and of the impulsion of the fragments of these *dikes* by the *streams* which had followed this direction. He had also mentioned to me the courses of the *Queis* and the *Schwartzbach*, as exhibiting the same operations, and had referred me to Baron Von Gersdorf for full conviction on this point. I observed the three former of these rivers during the following days; and the two latter were our object at present.

493. We proceeded first to the village of *Gräntzdorf*, which belongs to the estate of *Mäffersdorf*; we then entered *Silesia* by the village of *Herrnsdorf*, whence we went on to *Ullersdorf*, situated on the banks of the small river *Queis*, which arrives through a valley terminated by the high mountain of *Hohestein*. This river, at the point where we met it, passes between the *Hau-fuder* and another mountain; hence, continuing its course northwards, it joins the *Bober* a little above *Sagan*, and they afterwards proceed to-

gether to unite with the *Oder* at *Crossen*. This then is the whole extent of the space to which M. Meierotto had referred me for proofs, that the masses of stones scattered in low situations were fragments of *dikes* whereby *superior seas* had originally been retained in successive basins, one lower than another, each of which had been emptied in its turn by the rupture of its dikes; that this having extended all the way into *Sweden*, masses of the *granites* and *porphyries* of that country had been brought over to the lands on the south of the *Baltic*, by the ice of that sea, at its successively lower levels; and that the *sand* scattered over these same countries was the detritus of the masses of *granite*, rolled along and rounded by the torrents of the mountains. In the itinerary which he had made out for me, he had indicated the places where I should find examples of the above operations; I visited all these places, and likewise many others with the same view; and it will be seen what were the results of my observations, beginning with the river *Queis*.

494. When we approached that river by *Ullersdorf*, we were on its left bank; and we continued to ascend it on the same side till we came to *Flinsberg*, which is situated on a ridge of hills, and commands a view of the whole *valley* of the *Queis*, rising gradually towards the *Hohestein*. All the mountains within this extent have rounded summits, separated by *combes*, where springs produce the rivulets which unite to form the little river. Throughout the whole

space, there are no abrupt faces, and very few projecting rocks, though enough to shew the nature of the *strata*. In these it is seen that the slopes towards the valley are composed of *strata* of *granite*, and that, on the outer side of the mountains there is a ridge of *micaceous schistus*, like that which we had crossed in our way to the *Tafelfichte*; whence it is evident that the valley has immediately resulted from the *angular motions* of the masses of *strata* on its sides. There is also another respect in which these mountains resemble the *Tafelfichte;* namely, that their rounded summits and their gentle slopes are covered with fragments of their *strata*, forming a superficial soil, by which the *strata* themselves are almost entirely concealed. The road that I was to have taken, had I not been deterred by the wetness of the heath, was over the *Hohestein*, behind which I should have descended to *Schreibers-hau.*

495. I have now shewn what is the real nature of these *mountains;* they are masses of *stony strata* of various species, which remained at a higher level than the rest, during the general *subsidence;* and the most lofty amongst them still exhibit marks of this catastrophe; for besides that they are broken, their *strata* have undergone angular movements, and are so much shattered, that the whole surface is covered with their rubbish, as well on the summits as on the slopes, and in the hollows, whether the latter do or do not afford a passage to streams. As there are neither any higher mountains in the neigh-

bourhood, nor any steep rocks on the summits of the existing eminences, the masses of stone that are scattered on their surface cannot possibly be ascribed to the *rupture* of the *dikes* of a *superior sea;* these, however, are the only masses which, in places within the reach of *torrents*, are exposed to their action. During the rainy seasons, when the slopes are penetrated with water, the stony fragments easily slide into the beds of the *torrents*, and are thus carried down into the principal vallies, where these materials, being deposited in all the wide spaces, are spread by the waters, and mixed with sand, and earthy particles; and in this manner are formed meadows, of which the soil is raised by new sediments during every inundation. But in those narrow parts of a principal valley, where the river, when swelled, occupies its whole breadth from side to side, if any accumulations of rubbish are made by lateral torrents, the water, on meeting with these obstacles, rises against them, and impels them before it, being enabled to move even masses of a considerable size, in consequence of the instability of the smaller fragments on which they lie. During great inundations, the noise of the stones thus set in motion is heard on the beds of shallow rivers, where some are even seen to move: but, if the valley again widens, they are deposited below the defile. If, lastly, one of these narrow passages happens to open on the outer side of the mountains, where the water may spread without any impediment, we there find accumulated all the large masses which the stream has brought down from the mountains ever since it began to flow.

496. In my first Travels, I described very particularly these different effects of *torrents*, at the points of their arrival in the large low vallies of the *Alps;* and the *Schwartzbach*, to which M. Meierotto had referred me for a proof that the materials of the *dikes* of a superior sea had been brought down from the mountains and scattered over the plains, will afford me an example of the last of the above-mentioned cases. As I was desirous to see the spot at which this river issues from the mountains into a large open space, instead of returning from *Flinsberg* by *Ullersdorf*, we passed over the mountain of *Hermansdorf*, properly the schistose foot of the *Hau-fuder*, to the opening of a defile through which the *Schwartzbach* arrives from the westward. The bed of the river is in this part covered with large stones; and the Baron told me that he had been here with M. Meierotto at a time when the stream was very much swelled, and that they had really heard the noise of the stones rolling on its bed. But this is again a spot which absolutely contradicts that gentleman's hypothesis respecting the mode of the transportation of the blocks scattered over the plains; for we here saw accumulated all the masses which the stream had detached from its shores, and brought down so far as this, since it originally began to flow; such only excepted as had been taken away

for the purpose of building. Now these are precisely the same stones which cover the whole of the slopes of the hills, down to the river, and of which some, happening to fall into it, are carried along by its current: being confined within the defile, it rises against these masses, and forces them to yield to its pression; but, on issuing forth into a wider space, it immediately deposites them, propelling them no farther than to the extremity of a kind of promontory which has been formed by their accumulation, and which is continuing to increase in extent by the addition of new materials on its sides. The inhabitants have dug a canal along the top of this promontory, in order that the stream, when not too violently swelled, may carry the stones on to its extremity, instead of scattering them over the adjacent lands: this is indeed their quarry for building stones; or rather, the *Schwartzbach* is the carrier, who, taking up these stones at the foot of the mountains, brings them down hither for the convenience of the builders. This was the spot which M. Meierotto had particularly desired Baron Von Gersdorf to point out to me as demonstrative of the truth of his system; but the above observations sufficed to induce the latter to form a very opposite opinion. Now it will be seen that the case is the same in all the other places to which M. Meierotto had referred me for a similar purpose.

497. The weather being still rainy, I determined to continue my journey by the common road, en-

tering *Silesia* farther to the north through a very open passage in the mountains, and then going round by *Hirschberg*. Baron Von Gersdorf gave me a memorandum of the places through which I was to pass, following at first the outer side of the mountains; and he was so good as to lend me his own horses for the first stage. As I intended to set out very early the next morning, I took leave at night of the Baron and Baroness, and of the two agreeable companions of my excursion to the *Tafelfichte;* but this did not prevent my kind host from rising in the morning to see me again, lest any thing should be forgotten which might be of use to me during the remainder of my journey.

June 19*th*. I set out from *Mäffersdorf* at half-past 5; it was still raining, but after some time the weather cleared up. At first, the road led me a little away from the mountains; but I then again approached them, and followed their *schistose* ridges, passing through *Alt-Scheib*, *Heyde*, and *Neu-Scheib*, where I crossed the *Schwartzbach* to *Egelsdorf*. Here begin the excellent causeways, which traverse *Silesia* in every direction. At three quarters after 6 I arrived at *Friedenberg*, where I crossed the *Queis*, and afterwards passed over a hill called the *Hertzberg*, at the bottom of which I again saw *granite;* but at the top I found *basalts* containing transparent *olivin*. This is a *volcanic* sign; for I have seen *olivin* in the very evident *lavas* of the *Winter Cassen*, near *Cassel*, below the remains of a *crater*, the borders of which consist of *scoriæ*. I passed on the left the ancient castle of *Greiffenstein*, built on a *basaltic* eminence, and I afterwards crossed several villages similar to that of *Lohmen*, which I described § 458; these villages, extending some leagues in length without interruption, are built along the course of small rivers, and are inhabited, partly by husbandmen, who cultivate the slopes of the mountains, and partly by manufacturers, whose labours are assisted by the streams. I had great pleasure in observing the simple manners of these villagers, and their natural civility.

498. As I passed over the eminences in this road, I had a distinct view of a great extent of the chain of the *Giant's mountains*, which, at this distance, was perfectly dissimilar in appearance to that of the Alps, though, like the latter, it is composed of *strata* of *granite*, of *gneiss*, and of *schistus:* it rather resembled the chain of the *Jura;* the *strata* of the different classes not having been here thick enough, nor the subsidences sufficiently great, to form high mountains, rising in *peaks*, like those of the *Alps*. Having passed through *Ottendorf*, I arrived at *Langwasser* at a quarter after 8. Below *Friedenberg*, there are several *pools*, or small *lakes*, on the course of the brooks flowing towards the *Queis*, as well as on that of the various branches of the *Schwartzbach*. These *pools*, which I saw from the heights, are certainly the result of *cavities*, or, in other words, of greater partial *subsidences*, on the

courses followed by the waters ever since they have been collected into streams; now as, till these *cavities* are filled up, none of the materials propelled by the waters can possibly pass beyond them, it is very evident that, wherever this phenomenon is observed, the entrance of each *pool* must exhibit to our view the whole amount of the sediments which have been deposited there since the time when the streams began to flow; whence it plainly appears that they cannot have flowed during any very great number of ages. This is the general conclusion which I have drawn from the existence of *lakes;* and since I have already described, and shall continue to describe, so many of these, at all heights, and in very different situations, I flatter myself that the gratuitous hypothesis of the production of such *cavities* by *local causes,* subsequently to the birth of the continents, will no more be renewed against this great class of *chronometers;* for in every country they abound so much, that, independently of the marks which most of them exhibit of having been produced by the *catastrophes* of the *strata,* this circumstance alone would suffice to shew the absurdity of such a supposition.

499. *Langwasser* probably takes its name from one of these pools in its vicinity; and between that place and *Spiller,* I passed over a hill, on which, in the middle of a field, rises a small *basaltic* mount, not above 15 feet in height, and 100 paces in circumference: as I walked round the slopes of

its rubbish, I saw on the summit a rock, in which prisms, not very regular, lay flat, and presented their section on one of the sides. Beyond this, at *Bärthelsdorf*, I crossed the small river *Kemnitz*, flowing over a bed covered with stones; but they were overspread with *moss*, which is always a proof that stones do not *roll*. I mention this circumstance, because, in the sequel, we shall meet with the same river, at a lower point, under a very different aspect.

500. I stopped at *Reimnitz* to rest the horses, and employed the time in ascending an insulated eminence, of which the slopes had very different inclinations, on account of the situation of the *strata;* and the summit, as well as the gentle declivities on the sides, were covered with *granitic* rubbish, and cultivated. This summit was another very interesting *panorama.* Immediately around me, I saw on all sides many similar mounts, for the most part cultivated, and presenting no rocks of *granite* except on their sides. Between these and the *Giant's mountains*, of which my view became more and more distinct, there were vast numbers of pyramidal eminences, with rocks on their summits, some composed of *granite*, and others of *basalts;* a phenomenon belonging to all the low grounds around this chain of mountains and its different branches. These eminences rise in spaces forming a kind of basins, being those where the greatest *subsidences* have taken place. For wherever there

happened

happened to be great inequalities on the bottom of the caverns into which the mass of the *strata* sunk, their elevated points serving as a support to some parts of this shattered mass, it fell in pieces, and thus were produced as well these *eminences,* as the lower spaces around them. It was in this manner that the separated parts of the *strata* were subjected to the *angular movements* by which those of different species were brought to view. Whatever may be the nature of *basalts,* within this space they were disposed in *strata;* but in what order they were placed among the other strata, it is difficult to determine, because they are seen only on the summits of mounts, the slopes of which are entirely covered with rubbish. Now we here find that the rocks, on the summits of eminences at but little distance from each other, consist some of *basalt,* others of *granite,* and others of *gneiss* or *schistus;* yet the slopes are every where covered with rubbish of various kinds, which is an indication of great convulsions.

501. I afterwards proceeded to *Hirschberg,* where I arrived at half past 2. Here I entered the principal field of observation, which M. Meierotto, expecting that it would lead me to embrace his system, had recommended to my attention. Here also I was to be under the guidance of the same persons with whom he had viewed this tract himself, and whom he requested, in letters of which I was the bearer, to be so good as either to accompany me, or to send with me others who were equally well ac-

quainted with it; and besides this, he had even written to his friends by the post, that they might be ready to receive me on my arrival. The course of the *Bober*, and of its branches from the mountains, was now to be the chief object of my attention; and the first person to whom I was to apply for directions was M. FREDERICI, Syndic of *Hirschberg;* he was at home when I arrived, but was on the point of setting out on a journey; however he had already received a letter from M. Meierotto, and being desirous to gratify his wish, he had drawn up for me instructions relative to all which I was to observe; recommending me, at the same time, to his friend M. SCHAUM, who was perfectly acquainted with the country, and readily undertook to supply his place. It was agreed that, before I viewed the *Bober* in the neighbourhood of this city, I should go to observe its sources, and those of its different branches, on the slopes of the *Giant's mountains*, availing myself, for this purpose, of my recommendations at *Schreibers-hau*, (where, but for the rain, I should have begun my observations;) and that, on my return, I should follow the same river down to its junction with the *Oder*, a little below the issue of the latter from the mountains. For it was along this course that, according to M. Meierotto, I was to see the points of rupture of the *dikes* of a superior sea, and the impulsion of their fragments down to the plains.

502. Not staying at *Hirschberg* any longer than

was necessary to arrange this plan, I proceeded towards *Schreibers-hau* through *Cunersdorf*, *Herisdorf*, and *Warmbrun*, the latter of which places is much frequented on account of a hot spring, whence it derives its name; hence I went on to *Petersdorf*, situated in a wide intersection of the foot of the chain. Persons unacquainted with the magnificent scenery of the *Alps*, may certainly be struck with that which, on this road, presents itself to their eyes; but on this subject I shall chiefly remark, that, if those who consider *mountains* as belonging to a certain *primordial state* of the earth are withheld, by that persuasion, from entering on the study of geology by this previous question: To what cause is the existence of these eminences to be ascribed? it is because such persons, not extending their view in the vast field of natural phenomena beyond certain marks of catastrophes which they superficially behold, are consequently led to attribute the most remarkable ruptures and dislocations of the strata to those causes which have acted on the continents since their birth; and this was the case with M. Meierotto. When, however, the clue supplied by M. de Saussure has been carefully followed; when it has been perceived that all *mountains* are composed of *strata* which must have been originally *horizontal* and *continuous*, and that *eminences*, *vallies*, and *plains*, can only be ascribed to partial *subsidences*, and *angular motions* of the separated parts; these catastrophes will be found to explain, not merely the phenomena on account of which recourse has been had to particular causes, but the whole construction of the *mountains* themselves: this will appear no less evidently in the *Giant's mountains,* than I have already shewn it to be the case in many others.

503. As I approached *Petersdorf,* I saw that the whole front of the chain on this side was occupied by rocks much fractured and in great disorder, forming a multitude of pyramids; among these, on the left of the road, I distinguished the *Kynast,* a naked eminence, on which is a castle, and of which the whole outline is irregularly indented, with sections of *granitic strata,* nearly *vertical,* and very distinct. Here then it appears very evidently that these *pyramids* are nothing but *ruins* of the same *strata* which compose the neighbouring mountains, left at their present level in the part where the rest of their mass has undergone the greatest *subsidence.* Between these eminences are the beds, covered with large *blocks,* of the *torrents* which issue from the mountains. These *torrents* were considered by M. Meierotto as putting in motion the masses of the ancient broken *dikes,* and propelling them down to the plains; I therefore paid very particular attention to their phenomena.

504. From *Petersdorf,* having proceeded some way by the side of the *Little Zackel,* I crossed that stream, in order to gain the banks of the *Great Zackel,* or *Zack,* which I followed, turning towards

the left, till I came to a point where it issues from a cleft in the rocks. Above its entrance into this cleft, and below the opening of another, through which lies the ascent to the village of *Schreibers-hau*, there is a great manufacture of vitriol, belonging to Messrs. PRELLER and SCHAUL, to the former of whom my recommendation was addressed. This gentleman did not happen to be at home; but to him also M. Meierotto had taken the precaution to write beforehand, and M. Schaul had in consequence engaged to be my guide. It was only half past 4 when I arrived here, so that I had time to observe the objects particularly mentioned to me by M. Meierotto; namely, the cascade of the *Kockel*, above its confluence with the *Zackel*, and the bed of the latter river, on which large *blocks* of *granite* have been seen to move.

505. As I ascended, from the manufacture, the course of the *Zackel*, I saw it flowing at the bottom of a large cleft, from which rise slopes studded with rocks of *granite* interspersed with firs. In these sides also there are some wide and deep clefts; by one of them arrives the *Zackel* itself, and by another the *Kockel* rushes down in a cascade to unite with the former. The other clefts bring no water, because they receive none on the mountains; and it will appear in the sequel in what manner these two torrents enter their respective channels.

506. It is not surprizing, either that large *blocks*

arrive on the bed of the *Zackel,* or that, within a certain space, they move along it; for the rapid sides of the valley are covered with these blocks, and with many smaller fragments; and the channel of the river has resulted from a double fracture, attended with the subsidence of the intermediate mass, the much inclined bed of the stream being formed by the planes of the *strata* which compose this mass; so that, at the times when very heavy rains cause *blocks,* mingled with smaller stones, to slide down to this bed from the sides, both the torrents, being then much swelled, and not having room to spread, the stream formed by their union propels the *blocks* before it, the smaller stones beneath them serving as a kind of rollers to facilitate their motion over the planes of the *granitic* strata, which, as I have said, possess a considerable declivity.

507. M. Schaul led me up to one of the large *blocks,* which M. Meierotto had mentioned in his note as being certainly known to have changed its place by the action of the stream; it lay on a ledge of rocks forming the right bank of the river. M. Schaul shewed me the spot where he had himself seen it some years before, for its size rendered it remarkable; and how far it had travelled since that time was consequently very evident. On viewing the situation of things, I could entertain no doubt of the fact: the block lay on a smooth plane, and when the stream, very much swelled, entered this narrow passage, it rose against all the obstacles which

opposed its course, and drove before it such as it was able to move. But from this, no consequence can be deduced with regard to the *blocks* disseminated on hills, and on plains remote from mountains, without previously examining, not only what has occasioned the *rounding* of the *blocks* which we see on the bed of *torrents*, (that is to say, whether they have really been *rolled* along there,) but likewise whence such blocks originally proceeded.

508. I began my observations in this place by the examination of these two important points, especially with respect to this very *block* which was known to have migrated: its edges were *rounded*, but its *length* and *breadth* much exceeded its *thickness*, its form being a *flattened* and elongated oval, 7 or 8 feet long. It is easily to be conceived that the pression of a confined stream above may have caused a mass of this form to *slide* along on the surface of a hard smooth plane: but, in order to effect the *rounding* of its edges in *rolling*, the stream must have repeatedly *raised* it up on one side, and turned it over on the other; an action which the water cannot be supposed to have exercised on it. Now as we saw that most of the *blocks* on the bed of the torrent, where at present there was very little water, were of the same general form, that is to say, of small thickness comparatively with their breadth and length, M. Schaul agreed with me, that the *rounding* of their edges could not possibly have been effected by their *rolling*: of these, likewise, many had *slidden*

along this bed, and had been observed to *change their places* on it; a circumstance on which M. Meierotto laid great stress.

509. But how had these *blocks* at first arrived on the bed of the *Zackel?* It was easy, on the spot, to determine both this question, and that of the *rounding* of their edges. The *block* first mentioned lay, as I have said, on a kind of terrace formed by the plane of a *stratum* of *granite*, on which the effort of the torrent, when swelled, had caused it to slide; and in this spot the materials falling from the slope had consequently not been able to accumulate; but farther back, at some distance, these materials rose in a slope, which had assumed the form of a half tunnel, on account of a great fracture in the strata behind it. We entered this recess, and ascending one of its sides, we saw that the slope consisted of the sand of *decomposed granite*, and that above it there were rocks rising in great disorder. Now in this sand were great quantities of *blocks*, with their edges *rounded* exactly in the same manner as those of the *blocks*, which, having slidden, in very rainy seasons, down these sandy grounds, had arrived on the bed of the torrent. It is therefore not on this bed that these masses have been *rounded*, since they are found in the same state on the slopes which border it.

510. The *granite* of the greater part of these mountains is subject to decomposition by the action

of the air; a decomposition which begins on the *angles* of the masses, where all these causes have the most power, and continues along the surface, as the latter is laid open, unless from the nature of the *granite*, which differs in the degrees of hardness and tenacity of its ingredients, or from its particular exposure, it happens to be overspread with lichens. This is the source of the *granitic sand* wherewith, as will be seen, the whole country is here covered; and as for the *blocks* on such rapid slopes as that which I have just described, they, being already *rounded* by these actions of the air, slide by their own weight down the sand, whenever, after great rains, it is fully imbibed with water. From the spot where we stood, I pointed out to M. Schaul, on the opposite side, not only clefts, similar to that affording a passage to the *Zackel,* with *rounded blocks* on their slopes, but distinct rocks, which were composed of masses of *strata* nearly horizontal, certainly still occupying their original situations, though reduced, by the erosion of the angles of each mass, into blocks, apparently separated, and piled on each other. I have already spoken of the same phenomenon in the rocks of *sand-stone* on the banks of the *Elbe;* but these mountains will present examples of it, on a very large scale, in the *granitic strata.*

511. It is therefore very certain, in the first place, that the *rounding* of the *blocks* which are scattered over the plains affords no proof that these masses were transported thither by running waters, since

those still on the mountains are found to be also *rounded*, even before they have been delivered up to the action of the highest *torrents*. And as it is impossible to believe the *torrents* to have been the cause of this *migration*, so neither, for a yet stronger reason, can it be ascribed to the rivers; since the former, which are the only impetuous streams, if they flowed in less contracted channels, would not have power to communicate to these masses the motions observed within this short space. But on the course of all *torrents* there are some wide parts, where such motions cease, and where, consequently, all these masses are stopped. This is a circumstance which has escaped the attention of those who for a long time have pretended, that the *blocks* scattered on the plains have been brought down from the mountains; but I shall prove it by repeated instances along the whole of the road here traced for me by M. Meierotto himself.

512. It is through a fissure at a considerable height, that the *Kockel* arrives to throw itself into the bed of the *Zackel*, which flows in the principal cleft; and these two fractures of the strata meet at the point where began the *subsidence* of a large intermediate mass; a catastrophe which I shall presently shew to have been attended with others lower down.

513. We entered the cleft which affords passage to the *Kockel*; and by a path formed on its left bank

up a slope interspersed with rocks and fir-trees, we came to the place where the torrent, issuing from the fissure above, descends in a single fall from a considerable height. How is it possible to imagine that this stream, after having arrived at a higher point by a channel nearly horizontal, can have cut the rock below it at right angles? Nothing can be more evident than that it must have found on its course this abrupt cleft formed by the subsidence whence the valley itself resulted; and the following is the whole of the effect produced by this torrent. We passed between the cascade and the rock, which is covered with *moss*, in consequence of the humidity constantly preserved in this interval; and the moss extends up to the point where the stream, being impelled by the pressure of the water behind it, rushes forward from the edge of the rock. This we saw, as we ascended on one side of the cascade, up to its issue from the fissure.

514. After these observations, in which M. Schaul had taken the more interest from the remarks that I had led him to make while we had the objects before our eyes, he obligingly offered to be himself my guide the next day in my intended excursion over the neighbouring summits of the *Giant's mountains;* adding that he would lend me a horse, as we might ride part of the way. I accepted this offer with particular satisfaction; and he engaged a man to attend us on foot, and carry some provisions for us.

June 20th. We set out at 6 in the morning, and took the road towards the lowest and most considerable part of the village of *Schreibers-hau*, being that where the church stands. On quitting the manufacture, we first went up, by a very rapid slope, to the cleft, or *combe*, which I mentioned before as here rising from the left bank of the *Zackel.* A rivulet issuing hence was at present, as is the case in common seasons, so inconsiderable, that a part of its course was concealed from me by the grass; yet the sides of this cleft were neither less abrupt nor less high than those bordering the *Zackel*; they were covered with *granitic sand;* and the *blocks* of *granite*, which had fallen at their foot, were rounded in the same manner as those on the banks and on the bed of that torrent.

515. *Schreibers-hau* is another of the villages which are remarkable for covering as much ground as is occupied by many capital cities; but it does not extend in length, like those before-mentioned, which consist of a double row of houses following the course of a single stream; for it is built on a high slope intersected with many rills, and the houses are placed along the sides of all these, chiefly because there is here a great manufacture of cut glass, in which vast numbers of workmen are employed. After having passed through the lower part of this village, we entered a vale following the foot of the mountains, and separating them from all the broken and ruinous promontories which I had crossed on

this side of *Petersdorf*, and which extend along the whole of the chain. Here we saw the *Little Zackel* issuing from a deep cleft, with its sides and their summits studded with rocks and covered with firs, like those bordering the *Great Zackel* above the manufacture of vitriol, and those in the *sand-stone strata* along the course of the *Elbe*. The bed of this torrent was covered with masses of *granite*, which were *rounded*, but evidently not in consequence of their transportation by the stream, for both the slopes descending to its bed are entirely composed of *rounded* masses of the same kind, imbedded in a soil of *granitic sand*; so that the only operation of the torrent has been to wash away this sand from the *blocks* which have fallen on its bed, where, during great inundations, it carries them forward in the rapid parts of its course, but abandons them in the more horizontal spaces. Here we quitted our horses, and gave them in charge to a peasant, whom we appointed to bring them back to the same spot at a certain hour; and then, taking on with us the man who carried our provisions, we proceeded forward on foot.

516. We were now on the chain of the *Giant's mountains*, where the slopes are very rapid, and every where consist of *granitic sand*, in which large fragments of *granite* are intermixed. The lower parts of these slopes, where the surface is composed of an accumulation of large blocks, are covered with woods of firs; but the upper parts are in pasturage, the blocks being there buried in *granitic sand*.

sand. When we were at a sufficient height to command a prospect of all the lower eminences forming promontories branching off from the chain, we saw in those projections many large clefts with abrupt sides, which contain no streams, because they are properly *combes*, beginning on higher parts of the mountains. But the most surprizing phenomenon within view from this spot consists in the numerous *piles* of *granitic blocks* rising here and there among the firs. We approached one of the most remarkable groups of these piles, which bears a very appropriate name, being called *Die Brüder*; as if it were composed of a fraternity of *giants*. Not having been able to gain any information relative to the origin of the name of the *Giant's mountains*, I am inclined, from this circumstance, to ascribe it to these *gigantic families*, of which there are great numbers on this side of the chain; many similar *giants* being also dispersed on various parts of it, either singly, or in smaller groups.

517. In the *Brüder*, may easily be seen the cause which has produced rocks of a construction apparently so strange: a mass of *granitic strata*, split by vertical *fissures* in consequence of the shock resulting from the general subsidence, was left at a comparatively high level, while all the other parts of these strata either sank lower, or were overturned, around it. Where any of the rocks in this group stand very near each other, the *separations* of the *strata* are plainly seen to pass from rock to rock;

but the *masses* thus separated are no longer *parallelopipeds*, as they must originally have been; they are now *rounded* by the decomposition of their angles, and of a considerable part of their surface; so that they have acquired the appearance of *piles* of gourds, and the uppermost mass in each *pile*, being most exposed to the actions of the air, is reduced nearly to the form of an orange. M. Schaul having told me that he had accompanied M. Meierotto over this part of the mountains, I asked him whether that gentleman had observed these *rounded blocks*, which certainly never had *rolled*, and which ought to have engaged him to change his opinion that those scattered over the plains had rolled along the bed of the torrents, and had been propelled by the river to the outer side of the mountains: M. Schaul replied that M. Meierotto had not seen these phenomena; because, while they were ascending the mountain, rain had come on, and had prevented them from distinguishing objects at any distance. Thus it is that errors arise and are propagated in geology, in consequence of the opinions precipitately formed by those who have not had opportunities to travel over a great variety of mountains at different seasons, and in this manner to familiarize themselves with the different phenomena which those eminences exhibit. I had observed similar rocks of *granite* rising above the *peat* that covers the *Blocksberg* in the *Hartz*; and in the course of my present journey, I had seen rocks of *sand-stone* near the *Elbe*, which were likewise composed of *rounded* masses of *strata*. I had therefore not been surprized at the first *piles* of *granitic blocks* that I had viewed this morning on the sides of the valley of the *Zackel;* and these, of which I am now speaking, presented a spectacle of precisely the same nature, though of a more striking appearance.

518. Continuing to ascend, we came to the *Kockel,* which rises in the lower part of a deep cut beginning at the summit of the mountain; there are two of these cavities; and they are called *Schnee-grübe,* or *snow-pits,* because the snow commonly lies all through the year in that part of them which fronts the north. Indeed we found a great deal of snow at the bottom of the *Little Schnee-grübe,* where we first arrived, and whence issues the principal branch of the *Kockel;* this stream being afterwards enlarged by a junction with the other rivulets which here furrow the slopes of the mountain. In the part where we saw the torrent, it had excavated its rapid bed to a great depth in rubbish. When very much swelled, it continues to deepen its channel by impelling the stones before it; but it deposites them in the spaces where there is less declivity, and where its course is consequently slackened. It is on account of the mobility of the materials on all these slopes, that, wherever there are no deep original channels, the torrents frequently change their beds: this happens in the spring, during the melting of the snows, when some of the masses, still frozen, obstruct the course of the torrent, which then, impetuously

tinously throwing itself on one side down the rapid slope, soon excavates a new bed in the loose materials, though already covered with grass: and even after the stream has widened its channel to a sufficient breadth, it continues to wash away the sand from the parts over which it passes, where, for this reason, all the stones are found uncovered. We crossed several of the beds thus abandoned by the torrents, which we saw flowing at present in different channels.

519. At half past 8 we came to a large dairy, above the woods, called *Baude*, where we rested ourselves for half an hour, and then ascended directly to the summit of the mountain, leaving on our right the *Reiftrager*, a large promontory, which is as high as this summit, but beyond a certain space slopes downwards on all sides. At 10 o'clock we reached the top of the mountain, near a high rock called the *Blau-stein*, on account of the bluish colour of the stone; this stone is in very distinct *strata*, inclined towards the side on which we had ascended, but all much shattered: we found rounded blocks on the summit of this mountain, as well as on the lower part. It was here that I saw, for the first time, the *Pinus pumila*, or *creeping pine*; this species forms no trunk: its branches rise to the height of about 3 feet, then fall, and throw up others, which fall likewise, always, however, raising to the same height their lateral boughs, terminated by large tufts of leaves, and producing abundance of

cones. This is the only tree, if indeed it may be called such, which grows on the summits of the *Giant's mountains*, where here and there it forms large bushes in the manner that I have described; and as yet I had never seen it on any other mountain.

520. The summit, from the point to which we had first ascended, continues to rise towards the part where the two *Schnee-grübe* are situated: it was three quarters of an hour before we reached the promontory which separates them; and though the ground was much broken, we went on to its extremity. Here, as we faced the outer side of the mountain, we looked down over the whole of both these great cavities in the summit, the smaller of which was on our left hand, and the larger on our right. In carrying our eye from hence towards the exterior side of the chain, it would have been impossible to doubt that the highest ridge, on which we were now standing, had become such, only because the *strata* had subsided in its front. The *Schnee-grübe* were formed by partial subsidences at the top of the ridge; the masses that once filled up these vacancies having sunk, as I shall shew, below the level of the rubbish covering the slope under them. Hence we had a view of all the ridges of low mountains which I had crossed, through their vallies, between *Hirschberg* and *Schreibers-hau*, as well as of the course of our ascent from the latter place to the summit whereon we now stood; and

after the remarks in which I had engaged my companion on the road, he was fully disposed to agree, that this whole space exhibited merely a chaos of masses, reduced to their present state by a great *subsidence*, during which these eminences had happened to remain at a higher level than the rest.

521. The beds of the *Zackel* and the *Kockel*, as well as those of their branches, when viewed from this height, appear to be nothing more than furrows in the slopes of rubbish; and there is a proof, not only that the excavation of these beds has been the whole effect of the action of the streams on this side of the mountains, but that the abrasion of the precipices, which were produced by the subsidence of the rest of the *strata* in their front, cannot have been continuing during a long succession of ages. I said that the masses once occupying the two *Schnee-grübe* had subsided below the level of the rubbish proceeding from the last great catastrophe, and covering, on the slopes, the ruins of the sunken strata, which are only here and there perceived. Now in a line with these great cuts in the mountain, there remain on the slope deep *hollows* that have become *pools*, in which the water is perfectly limpid: several of these follow each other below the greater *Schnee-grübe*, and there is one at the foot of the smaller, whence issues the first branch of the *Kockel*. The steep sides of both the *Schnee-grübe* crumble down, because in winter the water freezes in the crevices of their rocks: their fallen materials form slopes, the

bases of which extend to the edge of the *pool* whence the *Kockel* issues, and to that of the highest of those below the *Great Schnee-grübe.* That this operation is still continuing is very evident, because these slopes are not yet covered with vegetation; fresh quantities of rubbish fall every year into the pools; nevertheless they are not *filled up.* Thus therefore, at this height, we find precisely the same *chronometer* which I have shewn on the course of all waters, wherever there are *pools* or *lakes.*

522. In one of the sides of the small *Schnee-grübe* I saw the section of three nearly vertical veins, which seem to be filled with the same substance as those pointed out to me in *porphyry*, on one of the sides of the *Plauen-grund*, by M. Werner, who had called this substance *trapp.* M. Schaul had had a near view of these veins; and he told me that their gangue was arranged in distinct *prisms.* It was not possible at present to approach them, the upper part of that side being abrupt, and the snow still rising up to the point at which they were open to view.

523. On looking down from the brink of the great *Schnee-grübe*, the height of the precipice is certainly very striking; but there are many in the *Alps* which are more considerable; and even in the *Jura*, the *Creux du Vent*, described in my journey to the mountains of *Neufchatel*, is on a much larger scale. But a similar cavity in the *Mole*, a mountain within a

few leagues of *Geneva*, is still more remarkable, on account of the circumstances which accompany it. When viewed from the neighbourhood of the town, this mountain has the figure of an acute cone; but it extends behind in the form of a sharp roof, being only the section of a ridge. The mountains belonging to this ridge, including *Mont Salève*, which is separated from the *Mole* by the valley of the *Arve*, consist of *strata* of *lime-stone;* and they form a chain of the same nature as that of the *Jura*, which they follow at a greater or less distance. It is very difficult to ascend the *Mole* on the grass that covers its *strata*, because, these strata being strongly inclined towards the valley of the *Arve*, their plane, on that side, forms the surface of the mountain. But many people, on arriving at the summit, without having heard any previous description of the scene which here presents itself to the view, have shrunk back from it with sudden terror. The mountain is cut down from the top in a semi-circular precipice, much deeper than the *Great Schnee-grübe*, and also much more abrupt; for when very large stones are thrown from the brink, they may be followed by the eye in their perpendicular fall, till they diminish to the size of butterflies. This precipice is the vertical section of the *strata* which are so much inclined on the opposite side; and as their upper point thus forms an acute angle, I was able to set on it astride, with one leg over the brink of the precipice. These great phenomena of the mountains should be seen, in order that it may be fully comprehended how imaginary is the hypothesis that *vallies* have been hollowed out by *running waters;* this hypothesis, indeed, is still repeated by some geologists of reputation; but, after an attentive observation, it is evident that these cavities have been produced by the catastrophes of the *strata,* of which we see marks impressed on all parts of the *mountains,* and even on the sides of all *vallies,* as well as on every *precipice.*

524. From the two *Schnee-grübe,* the summit continues to rise, but with great interruptions, up to the highest point, which is called the *Schnee-koppe, (snowy summit),* because it is covered with snow during great part of the year. We could not proceed to that point, because we were to return in the evening to the manufacture of vitriol. We therefore went no farther than to the eminence next in height, named the *Grosse-rad,* (great wheel), which had engaged my attention. The base of this eminence, on the side of our approach, presented a phenomenon of a very singular appearance; it has been called by some writer, in a picturesque description, the *Sugar-dish of Garagantua;* but it is, in itself, of the greatest importance, as manifesting the interior composition of these mountains, of the state of which within no judgment could otherwise be formed, except from the abrupt sides; because their surface is covered with *granitic sand,* mingled with *blocks,* and overspread by vegetation. We here found a zone several feet in height above the rest of the soil, and

of considerable breadth, which we could not cross without great caution, it being entirely composed of large *blocks* of a *granite* of the same nature as that of the *Tafelfichte*, white, with very little *mica*, and not liable to be *decomposed*, so that its blocks continue to be *angular:* there is no vegetation in their intervals, because no sand is accumulated by their decomposition; and in some places, where they were all large, the eye penetrated between them to as great a depth in the heap as any light could reach: they were not covered with the same grey *lichens* as other granitic blocks, but some parts of them were overspread with a brimstone-coloured *lichen*, and others with a rose-coloured species, which has a scent like violets.

525. This is not the only part of the summit of the chain where the above phenomenon appears; from the highest part of this mountain, similar *zones* are seen to pass across it, at various distances, in the same direction. Hence it appears that the *granitic strata*, which present their *section* at the summit, are so much inclined as to be nearly *vertical* in the mass of the mountain; and that, in some parts, there are between the rest some *strata* of that *white granite* in which little *mica* is contained. Of the composition of these mountains, no distinct idea could be formed from the abrupt parts here and there appearing in them; nor could it be discerned even at the *summit*, unless there were these differences of species among the *granitic strata;* for in consequence of the very catastrophe which has fractured and subverted the *strata*, this whole summit is covered with *blocks;* and if these were all of the same nature, they would have suffered the same effects from atmospherical actions. But no sensible decomposition having taken place on the *blocks* which covered the section of the *strata* of *white granite*, while those in the intervals were decomposed, and the sand produced from them was washed away before it was overspread by vegetation, these intervals are become lower, and the rows of the *blocks* of the white granite remain in relief above them. This difference of level is still increasing; for the rains are continually carrying away some part of the *granitic sand* from the wide intervals where it is produced, and where it is covered only by a thin turf, mixed with a great profusion of that grey and bitter ramified *lichen*, which has been for some years used in medicine under the name of *Iceland moss;* it having been known only as imported from that island, when it was first introduced into England and the north of Europe.

526. From the top of the *Grosse-rad*, an extensive horizon presents a great variety of very interesting objects. On the west, I saw a chain of lower eminences branch off from these summits, and advance northwards into the plains, where it was terminated by the *Tafelfichte*; and as in my road from *Mäffersdorf* to *Hirschberg* I had frequently caught a sight of the *Giant's mountains*, so here I had a

prospect of the whole tract over which I had then travelled, and of which the eminences were gradually lost in the fine plains of *Upper Lusatia.* This was a beautiful distant view; but I had more pleasure in tracing the features of nearer objects in a kind of large basin on the N. E. which was encompassed on one side by these mountains, and on the other by the heights behind *Hirschberg;* for this space was not only richly cultivated between the insulated mounts of *granite* and *basalts,* which, from this height, could no otherwise be distinguished than by their woody summits, but was farther embellished by a vast number of small towns and villages surrounded with gardens and orchards, and some large bleaching grounds in meadows which were constantly watered.

527. I here saw before me the whole extent of *Schreibers-hau,* and its houses looked like a great herd of cattle drinking along the sides of the rivulets that flow in their pastures; for, as I have said, these houses follow the course of the small streams, which descend through the *combes* wherewith the whole upper part of the mountain is intersected, and which, above the village, appear as if marked out by hedges, trees being planted on their borders.

528. From this height, M. Schaul pointed out to me likewise the two *clefts* through which the *Zackel* and the *Kockel* take their course to the point where the latter of these streams rushes down in a cascade

into the bed of the former. These *clefts*, at their upper extremity, resembled that into which Baron Von Block had led me at *Uttewalda*, and from which we followed the defiles leading towards the *Elbe;* and here also I saw several other clefts, on the same slope of the mountain with the former, and in all respects perfectly similar to them, but not communicating with any of the *combes* in which rivulets are formed, and consequently not affording a passage to any *stream*. After having observed in mountains many phenomena of this nature, (and in all mountains they are seen, in a manner more or less striking, but always originating from the same causes,) it is impossible to entertain any idea that the waters descending from the heights have produced either the *clefts* through which they enter the *vallies*, or any part of the *vallies* themselves.

529. On looking from this eminence along the chain to which it belongs, it seems surprizing that, when viewed from a distance, this chain can appear continuous: for not only do the mountains succeed each other in a winding line, but they are separated by several very deep vallies. Such a valley, for instance, divides the *Grosse-rad* from the following eminences, of which one that is very lofty, and projects beyond the chain, is called the *Mittagstein*, (south rock,) probably from its position relatively to some particular place: next to this, on the right, is the *Kleine Sturm-haube*, (Little Storm-cap,) so called to distinguish it from the *Grosse Sturm-haube*, which

is at some distance to the westward; probably some prognostics of storms are commonly seen on the summits of both. Between the *Mittagstein* and the *Kleine Sturm haube*, we had a view of the *Schnee-koppe*, the highest eminence of this chain: we were at so great a distance from it, that, unless we had known its height, we should not have ascribed to it the rank among these mountains which it really holds; it is separated from the rest by a large valley; and on its slope there are two lakes, the *Grosse Teich* and the *Kleine Teich;* the former is a league in circumference. In these *lakes,* from which issue small rivers, are collected all the waters of the upper slopes. Here then we find, on a large scale, a phenomenon similar to the *cavities* at the bottom of the *Schnee-grübe;* the basins of these *lakes* having been produced, in the same manner, by greater partial *subsidences;* and it is beyond a doubt that none of the masses which are on the lower part of the course of the small rivers issuing from them can have descended from the *Schnee-koppe,* because the *lakes* must have been filled up, before any materials could have been carried beyond them. In my description of the courses of the waters on these mountains, proofs will be found at every step, (and this will equally be the case on all mountains, when confidence shall no longer be reposed in superficial observations,) that no masses of stone, either small or large, have ever been transported by these waters down to the plains.

530. I have already said that the boundary line between *Silesia* and *Bohemia* generally follows the summits of this chain; but the chain itself is so irregular, that there are many exceptions to the rule; and for example, the *Schnee-Koppe* is in the latter country, out of this line. On looking from the *Grosse-rad* on the Bohemian side, I saw nothing but mountains behind mountains, retiring at last to so great a distance, that they appeared like the waves of the sea. M. Schaul shewed me the direction in which *Prague* may sometimes be discerned, when the air is very transparent, and the sun in a favorable position. As I looked that way, I could judge for what reason, when I had viewed this chain in my road from *Lusatia*, it had appeared to me *continuous*, with only some slight inflexions in its outline, except in the part where the *Schnee-koppe* rises above the rest; this had been, because, through the intersections of the nearest ridge, appear the summits of that immediately behind it, and so on from one to another: and hence, unless these ridges are separated by vapours, they form to the eye only a single mass.

531. I was informed by M. Schaul, and afterwards by several other persons, that the part of the *Schnee-koppe* which commands all the other eminences consists of *gneiss*. On this summit, therefore, the *strata* of *gneiss* have retained their original position upon those of *granite;* every where else, they have slipped down during the *subsidences*, and

have thus left the latter strata uncovered; but in many places they are again met with, forming interrupted ridges of lower eminences which follow the *granitic* chain, as has been shewn in the *Tafelfichte*, and will appear elsewhere in the sequel of this journey.

532. Among the very important objects that I had intended to observe in the *Giant's mountains* was the origin of the *Elbe*, the *river* which had chiefly fixed my attention in these countries, and which I have actually followed, at different times, along its whole course to the sea; I have already described a great part of its channel, but only between hills composed of *sandy* strata; in a future journey, I shall resume my account of it, in that part where it issues from the mountains, and enters the defiles of those hills; but at present I have only to speak of its origin in the mountains. This, while it will afford an example of the origins of all great rivers, will particularly shew how erroneous is the opinion of some geologists, that the *Elbe* has broken through high *dikes*, and thus opened for itself a passage from *Bohemia* into *Saxony*, continuing to scatter the fragments of these dikes on its course down to the plains.

533. The part just described of the *chain* of the *Giant's mountains* descends, on the side next to *Bohemia*, in seven *promontories*, separated by six *combes*, which begin from the summit, and slope

down to a low valley, passing along their front, and forming a seventh hollow space; this whole tract is designated in the maps of the country by the name of *Die Sieben Gründe; (the seven vallies;)* and in these channels are collected all the waters which descend on this side from the mountains. In our return from the *Grosse-rad,* we passed by the heads of all the above *combes:* now it is impossible to view the *rivulets* that enter them, with any idea that such vast *chasms,* of which, towards their lower part, the sides are abrupt, can have been produced by these feeble streams.

534. These are the first branches of the *Elbe;* but they are all distinguished by different names, excepting that which is most to the westward, on the back part of the *Blau-stein,* and which, even before it descends from this summit, is called the *Elbe;* it issues from the foot of a heap of granitic rubbish, where in the maps it has the title of *Elb-brunn,* the *source of the Elbe;* but this is a distinction merely arbitrary. Having crossed the other rivulets, most of which rise in marshy hollows, we stopped on the *banks of the Elbe,* above its junction with them, and in a part where it forms a small cascade. Here we spread out our provisions, and dined with a very good appetite; we had brought wine; but as we were very thirsty after our walk, we gave the preference to the water of the *Elbe,* of which we received the whole stream in a goblet; this water was very cold, for the spot whence it issued was still covered

with snow; but in all my excursions among mountains, I never experienced any inconvenience from drinking such water.

535. After our repast, we followed this rill, which is honoured with the name of the *Elbe*, and is increased, while flowing down the slope, by several other little streams that arrive to unite with it; we passed some of these on bridges of frozen snow, beneath which they had preserved their course. As we descended to lower ground, a slope rose on our left, and over this we were obliged to pass, in order to reach a spot, where the *Elbe* precipitates itself into a large cleft. On reaching the border of this cavity, I was much struck with its appearance; it is a cul-de-sac, similar to that described (§. 28.) at *St. Sulpi* in the *mountains of Neufchatel;* but the cleft which begins from this point is of much greater length; and here also there is a direct proof, though of a different nature from that observed at *St. Sulpi*, that the rocks have not been thus intersected by the action of the water; for the *stream* does not enter the head of the cleft, but is led by the inflexions of the ground above to the brow of a lateral *promontory*, from which it precipitates itself to the bottom. The water being at present low, it descended in several cascades; but during the time of the melting of the snows, the whole stream darts forward from the top of the rock; and I saw the spot where it then falls on a slope of rubbish, in which it has formed a deep hollow, whence the water oozes out on all sides.

536. I have

536. I have already remarked that, when water rushes in a cataract from the brow of a rock, it exercises no action there; and we observed this to be the case here, as well as on the brow of the cascade of the *Kockel.* There being so small a quantity of water in this particular branch of the *Elbe*, it threw itself forward at first no farther than to fall on a rock a little below. The rock being abrupt on both sides, we could not approach this higher cascade; but lower down the course of the stream, the materials fallen on one side had formed a slope of rubbish, covered with trees and bushes, along which I descended to the brow of the great precipice in the valley; and there, by taking hold of a branch of a tree, I was able to advance far enough to see the *cascade* in its whole extent, both above and below the point where I stood; now not only the rocks which lay under the insulated stream, but those on which it again fell, were covered with *moss* in every part; an evident proof that these rocks do not suffer any erosion.

537. The mountain which we had ascended, and which forms the right side of the defile thus precipitantly entered by the *Elbe*, is called *Elb-berg*, (*Elbe* mountain.) Hence we had a view of a certain extent of the defile, with its abrupt sides; but below this it turns to the left, and taking a S. E. direction, opens into the valley already mentioned as communicating with the six combes, the streams of which unite with the *Elbe;* and during the melting

of

of the snows, their waters greatly contribute to swell this river along its course. Beyond the tract distinguishable by the name of the *Sieben-gründe,* we saw a mountain called the *Silberberg;* but about half way between the *Elb-berg* and that large eminence, the chain is intersected on the southern side by a great valley, into which the *Elbe* enters, after having received on the east a stream formed by the collected waters of a vast number of other *combes;* for in these and in all mountains, the *combes* are incomparably more numerous than the *vallies.* The most remote of the rivulets which compose this branch rises in a high ground called *Weisse-wiese,* (*white meadows;*) and hence the branch itself bears the name of *Weisse Elb-brunn,* (the source of the *White Elbe.*) As we followed towards the east, the line of these great eminences separated by vallies, we had a distant view of the *Schnee-koppe.*

538. Terminating here our observations, we crossed the ridge of the mountain, following a line of high posts, which serve here, as is the case on *Mont Cenis,* to mark out in winter the beaten path, when it cannot otherwise be traced, on account of the snow drifted by the winds: this path forms the communication between several parishes of *Bohemia* and *Silesia.* At 3 o'clock, we came to the dairy at which we had stopped in our ascent; and proceeding hence on foot down to the bed of the *Little Zackel* we there found our horses, and reached the manufacture of vitriol at 6 o'clock.

539. By this time M. Preller was returned; and as he was the person whom M. Meierotto had particularly desired to shew me the *blocks* which were known to have moved on this part of the bed of the *Zackel*, I requested that he would be so good as to conduct me to them. He very readily complied; and I learnt from this gentleman, that, besides the changes observed in the heaps of smaller fragments, after every great inundation produced by the melting of the snows, some of the large *blocks* had been remarked to have also slidden some way down, the small masses acting as rollers under them. He led me to a bridge over the *Zackel* a little above the manufacture, and from thence he shewed me a very large *block*, which he said he had seen, a few years before, near the bridge, though it was now at some distance below it. With respect to the smaller masses, he shewed me certain parts where the river was fordable in common seasons, which saved foot-passengers the trouble of going round by the bridge; but he told me that, after every great swell of the water, it was necessary to repair these fords with the stones brought nearest to them by the stream; some of those which had lain there before, having been carried lower down. As at this moment there was little water in the river, I could observe a great part of its bed, consisting of the planes of the *granitic strata*. Now these planes being inclined, this is a base on which masses of considerable size may be put in motion, when the torrent arrives, much swelled, to enter this narrow passage.

540. As for the *rounding* of the edges of these large *blocks*, M. Preller agreed that, since they were all fragments of *strata*, and since, consequently, their superficies exceeded their thickness, they could never have *rolled*, but must have slidden along on their flat side, the smaller fragments rolling under them; and that therefore this *rounding* of their edges could not have proceeded from any other cause than that to which I assigned it; namely, the decomposition of their angles by the actions of the air; an effect that had been produced on the slopes of the mountains, before these masses had slidden down on their own *sand* to the bed of the river. He added that there were on this bed many other large fragments, which were rounded in the same manner, though they had certainly never moved since they had lain there, on account of their weight; and he pointed out to me as an example some immense masses, which supported the piles of the bridge; he made me remark, indeed, that as, when the river was much swelled, the water rose and broke around these masses, in the same manner as between rocks, fragments of considerable size might easily, at such times, be displaced; but he allowed that this was a local effect, produced by the contraction of the bottom of the valley within a certain extent; for he added, of his own accord, that, below the manufacture, where, as the right bank descended with a gentle declivity, the water, when very abundant, had room to spread, the larger masses no longer experienced any motion, though the stream continued to flow in

the same direction for some way, before it turned to the right. On all these points, therefore, both M. Preller and M. Schaul concurred in my opinion, as I stated in the paper which I gave, on my return, to M. Meierotto; who, after having had it in his hands for eighteen months, returned me no other answer than that he purposed again to visit these places; a purpose which, as I have said, his death prevented him from carrying into effect. I spent the rest of the day at the manufacture, and quitted it the next morning, very thankful to both the gentlemen for the kind assistance which they had afforded to me.

June 21*st*. I set out at six in the morning, and following the route traced for me by M. Meierotto, I proceeded along the foot of the mountains as far as *Schmiedeberg*, in order to see in the way some masses of granite, supposed by him to be the remains of the *dike* of a *superior sea* which had been broken on this side, and of which other fragments had been carried along the bottom of the vallies down to the plains. I only mention this, to shew what had been M. Meierotto's object in engaging me to take my present road; on which I will confine myself to the description of my observations, until I shall have collected all the facts.

541. I returned, as far as *Petersdorf*, by my former road along the course of the *Zackel*, which had no appearance in any part of this space, c

having afforded a passage to blocks. At *Petersdorf* I quitted that river, and turning to the right, proceeded through the villages of *Hernsdorf*, *Giersdorf*, and *Seydorf*, passing in front of those promontories, which, when viewed from above, had evidently appeared to be the more elevated parts of the masses that had on this side subsided: here also I saw their *strata* dipping under the superficial soil, like those of Mount *Kynast*, near which I again passed, leaving it on the left.

542. The different branches of the *Zackel* and the *Bober*, all of which I either followed or crossed, are the only *streams* that descend from this northern part of the chain of the *Giant's mountains*. The promontories of the chain, as I passed before them, clearly shewed the history of their *strata*, being all shattered, with deep clefts, whence issue the rivulets which, within a certain space, flow towards the *Zackel*; and over all the fore-part of these promontories, and the intervals between them, are scattered *blocks*, *rounded* by *decomposition*; as appears very evidently, since they are partly buried in a very thick soil, which consists entirely of *granitic sand*: in the cultivated spaces, these *blocks* have been taken up, and are laid along the sides of the fields. In some spots, also, there are detached masses of a much larger size, as well on the slopes, as at the foot of the mountains.

543. Here then we find a great abundance of *fragments*; and these are the masses which M.

Meierotto had in view; but what he sought was an explanation of the *blocks* scattered on the *plains:* now from the foot of the mountains where these fragments lie, to the bed of the *Zackel* by which he supposed them to have been transported, there is a very wide space, where the declivity is so small, that all the rivulets flowing across it have *pools* on their course, as is represented in the map. This space is even so nearly horizontal, that artificial *pools* are made in it, which, like those described in my *Travels on some part of the coasts of the Baltic and of the North Sea,* are for some years full of fish, and are afterwards drained and again brought into cultivation. Is it possible that these can have been channels for *blocks,* when they do not even afford a passage to *gravel,* the whole of which is retained in the *pools?*

544. At *Seydorf* I entered a large cleft with an ascending course; and I afterwards crossed a branch of the mountain in my way to *Arnsdorf.* Here I saw that all these projecting parts are separated from the body of the chain by a valley of considerable breadth, running from north to south, wherein flows one of the branches of the *Bober,* called the *Lomnitz,* which falls into the principal stream before it arrives at *Hirschberg.* The *Bober* is the receptacle of all the waters descending from the northern side of the *Giant's mountains,* within a space of four leagues, from the *Schnee-koppe,* which I saw on my right, to the mountains above *Schmiedeberg,* which lay on my

left, where the chain is interrupted by many vallies. The *Lomnitz* at present contained very little water; but I could judge of the abundant quantity which sometimes flowed in it, by the width of its stony bed, occupying the whole bottom of the valley. It is by no means surprizing that this space is covered with stones, and even *blocks;* for all the slopes of the mountains which come down to it are composed of these masses, and the bottom of the valley must, in the same manner, have been covered with them, before the waters began to descend from the mountains; in other words, before the birth of the continents: so that the whole operation of these waters has been to carry away the minute fragments, and to leave the stones bare.

545. Before I descended into this valley, I saw on the left, besides the small mountains in front of the chain, some very large pyramids which stand farther forward in the plain, along the left bank of the main branch of the *Bober*, and are so distinct from each other, that each has its particular name; the most remarkable are the *Bober-stein*, the *Forst-stein*, the *Falken-stein*, and the *Polzen-stein*. With respect to the masses of *strata* which have passed beneath the soil by a greater subsidence, these *stony eminences*, as well as all the smaller ones scattered over the basin extending from hence to *Hirschberg*, are like the masts of a ship, that appear above water, and indicate the spot where the vessel has struck on a sand-bank, into which it has sunk.

546. In my way from *Arnsdorf*, I looked with regret towards *Buchwald*, a seat belonging to Count Von Reden, chief of the mines of *Silesia*. I had met this gentleman the winter before at *Berlin*, and had had great pleasure in conversing with him about an excursion which we had made together above twenty years before in the *Hartz*, where he was then studying the labours of the mines under his worthy uncle Baron Von Reden. He had invited me to accompany him in a similar excursion this summer in *Silesia*, and I had set out from *Berlin* nearly about the time which he had proposed to me; but as the first part of my journey had occupied me longer than I expected, I had been told, when I was at *Schreibers-hau*, that he had already quitted *Buchwald;* which being confirmed to me in the neighbourhood of that place, I did not go there.

547. Crossing the valley of the *Lomnitz*, I came first to *Nieder-stein Seiffen*, and afterwards to *Buschfur*. This valley also has several *pools* at its bottom: I had a view of great part of both its sides, consisting of nothing but ruinous masses of *granitic strata* which follow each other, and amongst which I remarked one as being very characteristic of the catastrophe that produced the valley; this is a line of insulated rocks extending to a great distance, with both its slopes covered with fragments, and terminated by a detached rock in a pyramidal form; whence it evidently appears, that this mass

of the *strata* having found a support beneath in the partial *subsidence* from which the *valley* resulted, did not follow the rest to the bottom of the cavern wherein they sank. Nor can this explanation admit of any doubt; because, as has been seen, the same phenomenon occurs in the mountains of the country of *Neufchatel*, where, as the *strata*, which are *calcareous*, contain *marine bodies*, they must necessarily have been formed in a horizontal and continuous position on the bottom of the ancient sea.

548. At three quarters after 10 I reached *Schmiedeberg;* at which place M. Meierotto had furnished me with a recommendation to Dr. OSWALD, who gave me a very obliging reception, and offered me whatever assistance I might desire. Baron Von Gersdorf had particularly advised me to ascend the *Friesen-stein*, an eminence which stands at the extremity of a promontory advancing from the chain, and commands a fine view of the confused assemblage of mountains belonging to the county of *Glatz*, and to *Moravia.* At that moment, clouds were spreading over the summits of the mountains, and especially of the *Friesen-stein;* however, on the chance that these signs might prove equivocal, and that the air might become clear, Dr. Oswald proposed that we should try the adventure. Had the distant prospect been the only interesting object of our walk, we should have had reason to regret that we took this trouble; but there was much to observe in the mountain itself.

549. According to the barometrical measurements of Dr. Oswald, the summit of the *Friesenstein* rises about 1500 feet above *Schmiedeberg*, which place is at nearly an equal height above the level of the sea. On the spreading base of this mountain, nothing is to be seen but *granitic sand*, mixed with masses of the same stone, of various sizes, and all *rounded* by the decomposition of their angles, of which operation this *sand* is the result. But in the part where the acclivity becomes more rapid, there are some spaces that are occupied with *angular blocks*, the *granite* of which they consist not being sensibly *decomposed* by the actions of the air. We found the same alternation repeated towards the top of the mountain; and several of the rocks on the slope being of this latter kind of granite, we saw in them the *joints* of the *strata*, which are easily distinguishable from the vertical fissures whereby these rocks have been separated into a kind of columns. But the summit is merely a vast heap of *rounded blocks*, and of the *sand* produced by the *decomposition* of their angles: it is here evident that as, in consequence of this *decomposition*, the blocks have lost their support below, while the loose *sand* has accumulated around them, they have successively glided down the slope; for I found great numbers of these masses collected together in a wide space at the foot of the mountain. This is, on a larger scale, and with the differences necessarily resulting from those in the nature of the *granite*, the same phenomenon which I have described (§. 452.)

on the *Borsberg*, near *Pilnitz*, on the low *granitic* chain along the course of the *Elbe*; and I have also pointed it out on several summits of the *Harts*. This then is a large class of phenomena, (for there are many examples of it in other parts of the globe;) and it is manifestly of much importance with respect to the dissemination of the *blocks* and smaller masses over the hills and plains, by shewing immediately a very great effect of the *compression* of the *interior fluids*, consisting in the expulsion of these fragments from within, during the general *subsidence* of the strata around the *eminences*, whether *mountains* or *hills*; these eminences being only the masses, which after the various catastrophes undergone by the *strata*, remained at the highest level.

550. We employed four hours and a half in this walk; and no sign of better weather appearing on our return, I determined, though with regret, to continue my journey the same evening to *Hirschberg*, where I arrived at three quarters after 8. There are few spaces of the same extent which can present to the view an equal number of interesting objects, either geological or picturesque. The scalloped chain of the mountains was on my right; and I saw, in their front, rows of high rocks, which had remained on their slopes, or at their foot, during the *subsidence* of the rest of the strata. These eminences, as well as those scattered in the plain, brought to my recollection what must have been the appearance of the *steeples* in *Jutland*, and in the province

of *Dordrecht*, after the terrible catastrophes which happened in those countries some centuries ago; when the dikes, enclosing vast tracts of ground formed by the sediments of the rivers and the tides, having been broken down by tempests at the time of high water, the sea rushed in upón the lands within, and so greatly diluted them, that all the houses and other buildings which had been erected on them sunk down; nothing remaining above the level of the water but the steeples of the churches.

551. On the eminences of which I am now speaking, I saw rocks, 2 or 300 feet high: wherever the summits of the eminences are of sufficient extent, they are covered with firs which grow between these rocks; on the other parts, there are only bushes; and the slopes, composed of their rubbish, are overspread with grass. Some of the rocks have preserved their angles; but others are rounded, and I saw several which, by the erosion of the joints of the *strata*, have been reduced into piles of distinct *blocks*, like those on the *Giant's mountains*; some of these piles have fallen down, in consequence of the complete separation of the masses, which, where they have not found room to lie on the summits, have rolled down the slopes. The forms of the blocks depend on the thickness of the *strata*, and the size of the *columns* into which those *strata* were originally divided by vertical fissures; such masses as at first were nearly *cubical*, are now become almost spherical. Now around some of these emi-

nences I have observed the progress of *blocks* of different forms in their descent from the summits; the most spherical, having acquired an accelerated motion on the slopes, have rolled to a considerable distance on the ground below, which is nearly horizontal, and is covered with grass; the others have not proceeded so far, and some have not even reached the bottom of the slopes; so that, by the succession of the *blocks* scattered around these eminences, it is easy to trace their history, from the time at which they all were first delivered over to the different actions of the air.

552. Besides these, there are some large insulated masses on the low grounds, at a distance from the eminences. The whole soil of this plain, which is very fertile, is composed of *granitic sand;* but it is interspersed with large masses of granite; and wherever these masses have happened to consist of several *strata,* if their divisions have been horizontal, the rounded *blocks* into which they have been reduced have remained one on another; I saw some of these on high grounds, where certainly piles of this kind could no otherwise have been formed; for the blocks were of a very large size; and it is not possible to suppose that any of the ancient inhabitants of the country could have had the fancy to employ a great mechanical force to raise them upon each other in this manner for no purpose. As I approached a village, I saw some objects between the trees, at a distance, which I took for the ovens

of the villagers; but, on coming nearer, I perceived them to be two separate *blocks*, nearly round, from 15 to 20 feet in diameter: I made the postillion stop, that I might observe them; and he told me that they went by the name of *brod und käse*, being thought to resemble a *loaf* and a *cheese*.

553. We thus find that the operation of the air has been the same on all the masses of *granite* which have been left exposed to it, whether on the highest summits, on their slopes, or on the plains; the *rounding* of the *angles* of the blocks having taken place, in all these different situations, on the very spots where they were left by the catastrophes of the *strata*; and it is this which has produced the *granitic sand* forming the whole of the superficial soil: in this sand, none of the smaller masses are found but at a certain depth; so that those above this depth have been entirely decomposed; but the larger fragments, which have been only *rounded*, remain at the surface. Wherever the *granite* has been of the kind not susceptible of decomposition, its masses have continued *angular*. This *operation* has been effected out of the reach of any *stream;* for the space of which I am speaking lies between the *Zackel* on the west, and the two branches of the *Bober* on the east; and the only action of the various rivulets which cross it, in their way to join these two rivers, has been to spread the *sand* during their inundations; for they have not even carried along with them any *gravel;* almost all of them having found

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on their course cavities, which they have not yet filled up, and which consequently remain *pools.* Thus, exclusively of the atmospherical actions just defined, and the levelling of the sand during floods, nothing within this space has undergone any change since the continent has existed; in particular, no mass of stone has been carried down from it by streams into the *vallies,* much less as far as the *plains;* which was here the principal point to be established. However, as it is customary to search suspected persons when they come out of a house where some theft is supposed to have been committed, and not to acquit them till it is certain that nothing can be found on them, I resolved that, as I had observed the principal *streams* which unite at *Hirschberg* under the name of the *Bober* in the upper part of their course, so I would now continue to follow that river down to the point where it issues from the mountains, and joins the *Oder.*

June 22d. As M. Schaum informed me that it would be possible for me to keep the *Bober* contantly in view, if I travelled on horseback, with a man to lead round the horse when I came to parts where its course could only be followed on foot, I did not set out this day, because the morning was very rainy. But the weather clearing up in the afternoon, M. Schaum proposed to me that we should take the opportunity of visiting a spot which M. Meierotto had particularly recommended to my observation, and which bears a name very characteristic of its aspect; that of *Welt-ende*, the *end of the world.* I was indeed to see it from above, in my intended journey on horseback; but M. Schaum assured me that I should lose a great deal if I did not take a lower path, in order to enter this extraordinary chasm, which had all the appearance of a descent into *Tartarus;* he offered to accompany me, as did also Dr. THEBESIUS, one of his friends; and we set out together on foot at 2 o'clock.

554. Before we reached this place, however, we were to observe the *Zackel* near *Hirschberg*, where it arrives after it has passed through the country in which I have already described it. I have shewn that, in the higher part of the course of this stream, there are, in some places, many large *blocks* on its bed; now if it had brought these down from the mountains, and were still continuing to carry them on into the *Bober;* and if the latter river conveyed them to the open country, according to the opinion of M. Meierotto, who had sent me hither for proofs that this was really the case; at least blocks should be seen on the bed of the *Zackel* the whole way above its confluence with the *Bober*. But not the smallest vestige of any blocks appeared on this part of the course of the former river, which here flows in a plain: the stream was at present several feet below its banks; and no masses of sufficient size even to ruffle its surface were lying on its bed, of which it occupied the whole breadth, in consequence of the late rains, though its water was still very shallow.

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My companions told me that, in dry seasons, this bed might easily be crossed on foot, since it was covered only with stones of a moderate size, like those in the adjacent soil, from which the river had merely washed away the sand: it can never have here possessed any rapidity to transport stones; for, when it rises above the borders of this hollow part of its channel, it finds on the right a spacious plain where it can spread, and where it evidently does not exercise any action, since the soil near its bed is laid out in gardens, which it fertilizes by its inundations, without doing any damage to the culinary plants. The *Bober* enters this plain on the right; and the two rivers unite a little below *Hirschberg*. After an attentive consideration of this spot, it is impossible to suppose that stones, and much less *blocks*, can at any time have been brought hither by either the *Bober* or the *Zackel;* the common operation of both these rivers has merely been to raise the soil of the plain by the *sand* which they bring down in their inundations; and it is well known that they are still continuing to raise it in this manner; a proof that they cannot have flowed during many centuries.

555. The two rivers, when united under the name of the *Bober*, continue for some way to flow in a horizontal bed, which has a hill on the left, while its right bank is formed by the plain. But, as we proceeded between the hill and the river, the latter suddenly turned to the left, and disappeared. It is this part of the course of the river which is called

the *End of the World;* and indeed it seemed the final termination of all things, and might have furnished a poet with an image of the return of chaos. The *Bober* here precipitates itself into a narrow and rapid defile, where it foams amidst immense masses of *granite;* and the steep rocks which command this scene of desolation seem threatening to crush by their fall any one who may venture to pass along the space remaining when the water is low, as was the case at present, between them and the cataract: we were bold enough, however, to follow, betwixt the blocks, a narrow path, which sometimes led us over the slopes at the foot of this abrupt side; and we soon came to a point whence we had a view of the whole extent of the *Welt-ende*, which here appeared to be completely a *cul-de-sac*, like many of those that I described in the mountains of *Neufchatel;* there was absolutely no passage to be seen for the *Bober.* But, as we continued to follow the left bank, at last we descried, near the extremity of this cul-de-sac, a fissure from the top to the bottom of the mountain, through which the river rushes. In the plan of my road traced for me by M. Meierotto, he had called this a *rock cut through by the Bober;* it is therefore under this point of view alone that I shall at present speak of it.

556. Let us first consider the *Bober* in that part of its course where it suddenly turns to enter the *Welt-ende;* this defile being a fracture in the very hill along which the stream has hitherto calmly

flowed, while its right bank has been formed by the plain, or large open space, already mentioned. Let us now suppose the hill to have been continuous, at the time when the rain waters, beginning to flow along the surface of our continents, were first collected in this spot: they must naturally then have produced a *lake*, which would have extended considerably above *Hirschberg*, and would have found a discharge at some point much below this hill. The waters of *lakes* exercise no action except by their waves, which, as they attack equally the whole circumference of the basin, and not any particular part of it, could never have cut through, from top to bottom, a very wide hill of *granite*, so long as they had elsewhere a free discharge. Hence it is evident that, before the rain-waters were collected in this space, this fracture must already have been made by those catastrophes of the *strata*, to which must be attributed the many similar clefts wherein no waters flow. Let us however suppose the defile to have existed at the time when the stream was formed, but to have had at first no issue. The whole of the cavity would then have been filled with water, up to the lowest point of the rocks which encompass it; and from that point the river would have fallen in a cascade. Now it has been seen in the falls of the *Elbe* and of the *Kockel*, and it is indeed everywhere the case, that cascades do not erode the rocks from which they rush. But it will farther appear in the sequel, from the very nature of the fissure here affording an issue to the *Bober*, that it also must have been produced by the catastrophes of the *strata*, before any water arrived to pass through it.

557. The *Welt-ende* is much widened at its lower extremity by the retreat of the rocks on the left, which rise in a slope up to the top of the hill, but with several projections and abundance of *blocks;* and as these blocks lie only on *granitic sand*, they roll or slide down the rapid declivity, at times when the soil happens to be penetrated with water, after great rains, or thaws of snow. Beneath the rocks that apparently close this extremity, there is also a slope of rubbish, resting on a rocky ledge, which retains not only the smaller fragments, but the *blocks* likewise, when they slide down the declivity above. The *blocks* on this ledge, as well as all the others accumulated at the bottom of the defile, are already *rounded;* which I pointed out to my two companions, who had been here with M. Meierotto, and who readily agreed that the figure of these masses by no means implied that they had been propelled by *torrents*. Amongst the rest, we saw a very large *block* of this form, which had arrived on the ledge, and partly projected over it, near the fissure that affords a discharge to the river; hence we could judge that whenever any great swell of water should spread over this terrace, and carry away the sand from the foot of the slope above it, (which contributes to support the *block*,) the latter would fall into the great heap of similar masses already accu-

mulated on the bottom of the defile; where, unless purposely removed, they will certainly always continue; there being no possibility that any of them should ever enter the fissure itself; which will very evidently appear, when I shall describe it as viewed from above.

558. The side of the defile opposite to the fissure through which the *Bober* rushes, is formed by the slope of a mountain, called *Helicon* by the inhabitants of *Hirschberg*, who have cut paths in this slope, which they have laid out in a kind of poetical pleasure-ground. The highest rock on the *Hirschberg* side is crowned by a *Temple to Apollo*; and in the descent from this are several retreats for the *Muses*, in groves adorned with seats, on which are sculptured many classical subjects. The walk carried through this amusing pleasure-ground opens sometimes on very beautiful prospects, and afterwards returns into the woods.

559. The whole of the scenery here derives its picturesque appearance from the effects of the catastrophe which has produced in the *Welt-ende* the very image of chaos: many partial subsidences in the mass of the mountain follow the direction of the defile; and on the slopes there are many projecting rocks and large *blocks* interspersed with fir-trees. The surface being covered with a thick soil of *granitic sand*, the parts least obstructed with *blocks* have been cleared and cultivated: the *blocks* taken

up here are *rounded* in the same manner as those on the summits and on the slopes; and we saw many of them laid along the sides of the fields, which are very fertile. The lower spaces, where moisture is longest preserved, are covered with grass. In the higher parts, the superficial *strata* are of *gneiss*, beneath which is *granite;* and though I had not perceived any *basaltic* eminence, I saw some *basalts* on the slope; a sign that all these *strata* have undergone great successive catastrophes.

560. The *Temple of Apollo* commands a view of nearly the whole chain of the *Giant's mountains*, terminated on the west by the *Tafelfichte*, and on the east by an eminence, around which the *Bober* flows as it issues from behind that chain, and on which stands the town of *Kupferberg*. Dr. Thebesius was so good as to give me an outline of the chain, as it appears from this spot. I have already said that, in its general form, it much resembles the *Jura;* and I am the more inclined to believe that the name of the *Giant's mountains* has been given to it on account of the gigantic piles of blocks, which I described §. 416, because in height it is rather inferior to the latter chain. For I am informed that the *Schnee-koppe*, the most lofty of its summits, is 5000 feet above the level of the sea: now the *Dole*, which is the highest summit of the *Jura*, according to my barometrical measurement, is 5082 feet above the level of the *Mediterranean*.

561. On our return to *Hirchberg*, M. Schaum assisted me in arranging my future journey, according to the plan of M. Frederici. I sent on my chaise, with post-horses, to *Löwenberg*, 4 miles lower down on the course of the *Bober*, because M. Meierotto having mentioned several places which he wished me to observe on that course in the interval, I had resolved never to lose sight of it, but to follow it on the heights which border it. With this view, I hired a horse, with a man who was to serve me as a guide, and to lead the horse in those parts where I could only proceed along the river-side on foot.

June 23d. I set out from *Hirschberg* at half past 5 in the morning, by a road which first led me over *Helicon* as far as the lower extremity of the *Welt-ende*, where I alighted, and walked along the upper part of the rocks that close this extremity, till I came to the edge of the fissure which affords a passage to the *Bober*. From this point it very manifestly appears that the aperture is not the work of the river; for could it even be thought, in opposition to all that I have said of the inefficiency of *cascades*, that this stream, beginning to fall from the highest point, had here cut through the rock from top to bottom, it still could have acted no otherwise than as a *saw*, without producing any enlargement on the sides. Instead of this, the passage of the *Bober*, which is narrow at the entrance, becomes afterwards considerably wider; it then contracts itself, but is again enlarged as it turns to the left; and the river, when it at last issues from the defile, enters a vale behind the hill, where it flows in the same direction which it had followed before it entered this lateral rupture.

562. We have therefore here direct proofs that the abrupt rocks between which the *Bober* passes, and the vast accumulation of *blocks* in their interval, are the effect of catastrophes antecedent to the period when this stream began to flow, or, in other words, to the birth of our continents. It has been seen that the *Bober*, before it enters the *Welt-ende*, flows calmly on a bed along which it can never have propelled any *block*, since it forms a *lake* during its inundations. Now the case is the same at its issue from this cavity, when it emerges into a space where I saw that it must necessarily spread its waters, whenever it overflowed; and my guide accordingly told me that here also a lake was at such times formed. This, then, is not a channel which can possibly have afforded a passage to *blocks*; and all those produced by the catastrophe are certainly still remaining in the *Welt-ende*. In consequence of the width of the space which the *Bober* here enters, there is not in general sufficient water in this river to turn undershot mills; and it has therefore been found necessary to procure an artificial fall. For this purpose, a canal has been cut which, diverging at a certain point from the bed of the river, follows the side of a sloping ground on the right, in a nearly horizontal direction, till it is at a sufficient height above the level of the stream to fall with the requisite force, on

the wheels of some mills. In order to turn the water into this canal, and to open for it a free course when it exceeds the necessary quantity, a dike has been made, which obliquely crossing its usual bed, obliges it to take this new direction; but on the outer side of the dike there is a long slope of planks, down which the superfluous water pours itself. A pond is consequently formed above the dike, at about 100 paces from the *Welt-ende*, and the water in it was at that time so clear, that, as I looked down upon it from this high point, I could see that there was nothing on its bottom but small *gravel;* though it must evidently have been filled up, had any materials passed over the dike. No *stones*, therefore, are brought down hither from the *Welt-ende* ; and all those heaps of *blocks* which are found there, whether produced at the moment of the catastrophe, or since fallen from the abrupt and shattered sides, remain within that cavity, where they are partly consumed by *decomposition:* thus nothing comes forth from it but the *granitic sand*, which, being spread by the river during inundations, forms the whole superficial soil of the plain below.

563. After all that I have said of this defile, out of which it is very certain that no stony masses have been brought by the *Bober*, the only stream here under consideration, it cannot be supposed that any have issued from the great tract of mountains, hills, and plains, which, in this country, has been the object of my observations: all such as have been set

in motion either by this river, or by the *Zackel* above *Hirschberg*, have served only to fill up the cavities, and to level the open spaces on the course of both the streams; and even these effects are gradually diminished, by the straitening, clearing, and widening, of the narrow parts of their channels. This is what has happened in all mountainous regions, where those disasters, of which ancient chronicles contain accounts, now so rarely occur. From time to time, indeed, the sudden fall of some abrupt side of the rocks is occasioned by internal fissures, which the water, carrying down into them the minute particles collected in its course, makes every winter, when it is frozen, a powerful effort to widen; or some of the large slopes of rubbish, which have risen against such sides, slide down after long rains, if any rill has penetrated between them and the rocks behind them. But accidents of this nature only contribute to reduce to a fixed state all those parts of the mountains which had been left exposed to them by the previous catastrophes of the *strata*.

564. This defile must have been very superficially observed by M. Meierotto, since, in his itinerary, he desired me "to take notice of the size of the stones "*already rolled* down to *Bober-Röhrsdorf*, and "thence to *Rober-Ullersdorf*;" (two places below this on the course of the *Bober*.) For, if he had paid attention to the facts which I have above adduced to prove that no stone has been brought by the stream out of the *Welt-ende*, he would not only

have plainly seen, in the very places to which he referred me, that none of the stones in question had ever travelled on the bed of this river, but would also have perceived the source whence they really proceed. As I approached those places, I found this bed become so wide and so horizontal, that not even the greatest abundance of water could possibly set any *blocks* on it in motion; for the stream flows between these masses and over them: but the slopes on the sides are covered with *blocks*, lying on the *granitic sand*, on which they slide downwards in very rainy seasons, as I have elsewhere shewn: there were some on a steep part of the bank, 7 or 8 feet above the level at which the river then flowed; now when the stream is swelled so much as to fill the whole of its channel, the base whereon the blocks lie being sapped by the water, they fall, and remain on its bed; but by this process, the bed is widened, and the banks continuing to retreat, will at last be reduced into slopes, and covered with grass, as in some parts is already the case.

565. The bed of the river, continues thus covered with *blocks* a little way beyond the bridge of *Bober-Rhörsdorf*, by which I crossed over to the right bank. That these *blocks* are stationary is very evident: for lower down is a space where there are none, and where the river flows calmly; it then again foams among blocks; but afterwards it resumes its tranquil course for a considerable time. In this part, however, it is again bordered by *granitic* hills, in which

there are projecting rocks, and of which the slopes are covered with *rounded blocks;* but here, when swelled, it has room to spread; and the *blocks*, sliding down the slopes in rainy seasons, fall on its bank, where it does not move them: it has even formed on its course some islands, which it still covers in its great inundations; for no grass yet grows on them; but, instead of attacking them, it only spreads over them gravel and sand: below these, it is again, for some way, ruffled by *blocks* on its course; but afterwards its bed is so much widened as to form a kind of *lake*, through which it flows very slowly.

566. When I came to the lower end of this wide space, I saw that the level of the river was here raised by a natural dike, consisting of a mass of *granite*, which, in the subsidence that produced the valley, had remained higher than the other masses, and above their rubbish. After having had frequent opportunities of observing phenomena of this kind, it is impossible to retain the slightest idea that *rivers* can have *excavated* their channels in *rocks;* since they have not even cut through these *bars* which obstruct their course in their very beds. In my Travels already published, I have pointed out the same circumstance on the *Dartmoor* hills in *Devonshire;* and I shall soon have occasion to give a new example of it. Rivers rise, in order to pass over these bars, but they cannot destroy them by erosion, because, as is shewn by the growth of aquatic plants

on the bottom, it is always the surface of the water that falls. All the materials, therefore, which the stream has been able to bring down to this point, are deposited in the deeper space above the bar: if there is a sufficient abundance of them, they fill up that space, and the water continues to flow over them and over the bar; but this is not yet the case in the spot of which I am speaking, the cavity is not filled up, and the *Bober* is perfectly limpid when it passes over its bar; not bringing down with it any thing in its inundations, except such minute particles as remain suspended in those streams which still, during floods, attack some parts of their banks.

567. Below this *bar*, the *Bober* flows for some way with so much rapidity as not to leave any sand betwixt the *blocks* which lie on its bed: it here passes between hills with steep slopes, whereon there are great numbers of rounded *blocks*; some of these probably slide down to the bed of the river, when the sand on which they lie, and which is not covered with grass, is penetrated to a great depth with water; but a particular circumstance affords a direct proof that they do not move on this bed: I observed that the fore-part of these blocks (by which I mean the lowest on the course of the river) was covered with *moss*, as was also partly the case with their sides; but on their higher end there was scarcely any, undoubtedly because of the sand brought down by the stream, which beats against them at that end, when sufficiently swelled to cover them.

568. At *Bober Ullersdorf* a wide basin is formed by the retreat of the mountains on both sides. Advantage has been taken of a large rock of granite rising in the midst of it, for the purpose of throwing over it a wooden-bridge, which rests on piles, till it meets this firm support in the centre. Here also a dike obliquely crosses the wide bed of the *Bober*, whence a stream is thus led to supply some mills on the right bank: the river being here of a considerable size, part of its water passes over the inclined plane of the dike, and is carried, in several rills across a space levelled by the sand and the gravel, and now become dry. Here then we again find a kind of sieve, in which the river leaves behind whatever materials it has been able to bring down to this point.

569. As this basin, during inundations, becomes a *lake*, it is impossible that any part of its borders can ever have been attacked by the *Bober;* yet below it, this river enters a long defile with abrupt sides, which, in some places, it entirely fills; and there being consequently no space on the banks of the stream, the road is here carried a great way round. That the river could never have had power to cut for itself this passage through the mountain is the more evidently seen, because, had its water ever been at the level of the higher part of the sides of the defile, it must have formed a large *lake* on the right, where the bank is quite open. I asked my guide whether he thought that I could pass on foot along the

top of the rocks, without losing sight of the bed of the river: he told me that I should find it very difficult, but that, if I met with any obstacle which stopped me, I might at any time return to the road: I therefore resolved to attempt this way, while he followed the road with my horse. I succeeded in my undertaking, though not without much fatigue, as I had some very steep rocks to climb and to descend; but this I did not regret; for I found many interesting objects of observation, as well on the bed of the river, which I kept constantly in view, as on the abrupt sides of the defile itself.

570. The bed of the *Bober* is here again, in two places, crossed by *bars*, consisting of masses of *strata* left at a higher level than those from the *subsidence* of which this valley resulted. Above these *bars*, the river still flows slowly; and on arriving at them, it finds a passage through winding fractures, in some parts of which, however, it is so much confined, that, when greatly swelled, it rises, and a portion of its water flows over the *bars*. As I proceeded, the opposite side of the defile retreated, and my road lay over an eminence which was cut down abruptly towards the river: on the first part of the ascent, I found a great many *blocks* of *granite;* but when I gained the summit, I was much surprized at its appearance, for it was composed of a vast number of spheroids which were arranged in such a manner as to give it a resemblance to a *bunch of grapes*. The name of this eminence is probably descriptive of its appearance

when viewed from some different point; it is called the *Nelken-stein*, or Clove-gilliflower rock.

571. In this part of the defile, I saw the whole of the opposite side, from top to bottom; and it will afford a new example of the disorderly state of the masses of *strata* divided by the catastrophe which produced the *vallies* between the mountains; a state occasioned by the unequal *subsidences* of those masses. This opposite side is at the same level as the other; but though both consist of *granite*, the *species* are different. The *strata* on the side were here very distinct, and strongly *inclined;* I could not see whether they had the same inclination with those on my side; but I perceived very plainly that their fragments, as well on the summit, as on the banks of the *Bober* below, were *angular ;* a proof that they were of a *granite* not liable to decomposition; while all those which belonged to the *strata* on the right side of the river were, by this process, reduced to a *spheroidal* form; as I have instanced in those composing the summit of the *Nelken stein*: on a lower part of the course of this stream, still greater contrasts will appear.

572. When the *Bober* has passed through this winding defile, it resumes, at first, a very tranquil course; but as I proceeded along the brow of the rocks, I came to a spot whence I beheld a scene of a truly astonishing nature. I here saw, in the rock on the opposite side, several wide *clefts*, in front of the largest of which, in a part where that side re-

treats,

treats, an immense accumulation of *blocks* forms a kind of dike across the *Bober;* and in the midst of this heap, a small river, issuing from the above *cleft*, arrives to join it. This small river is the *Kemnitz*, which I described § 499, as flowing in the high ground above, on a bed where the stones are covered with *moss*, a little before it rushes into this narrow passage, to discharge itself into the *Bober*. It is certainly not the *Kemnitz* which has produced this *cleft*, since there are, on the same side, so many similar openings whence no water issues. It is equally certain that the immense accumulation of *blocks* at the point of the junction of the *Kemnitz* and the *Bober* has not been formed by either of these two rivers; for as the spot in which I stood commanded a great extent of the valley, I saw them flowing together very calmly but a little below this chaotic scene.

573. Proceeding onwards in the same direction, I came to a point where a large *combe*, which rises up to the top of the mountain, opens below on the right bank of the *Bober;* and on descending into it, I found my guide there waiting for me with the horse. This *combe*, as its lower extremity, is wider than many parts of the *valley* of the *Bober;* yet, notwithstanding the late *rains*, no stream but a mere rill was flowing in it. This is, more or less, the case with all *combes;* and I have shewn, at the beginning of these Travels, how important it is in geology to distinguish them from *vallies*. It is evident that these different kinds of interruption in the continu-

ous mass of the *strata* must both have been produced by one common cause: now superficial observers, when they see *streams* passing through *vallies*, may easily be led to suppose that the latter have been excavated by the former; but this illusion must cease in *combes*, which can never have afforded a passage to any water but that of the drops of rain immediately falling in them, or of the springs issuing from their sides, in consequence of those *fractures* of the *strata* in which both *combes* and *valleys*[*] really originated. Moreover the *combe* now under consideration presents a new example of a circumstance sometimes attendant on these catastrophes; namely, that, the whole mass of the *strata* having been subverted, some strata are now found at the same level with those others whereon, at first, they certainly were formed. The side of the combe which I had descended is composed of *granitic strata*; while the opposite side consists of *strata* of *schistus* and *gneiss*.

574. In this place appears also a case which is very frequent in the great vallies among mountains, and which furnishes one of the documents of the history of those vallies. The *combe* above mentioned being very wide and low near the *Bober*, that river has here room to spread, and has accordingly levelled this space during floods; yet it passes afterwards through a defile of the *schistose* mountain. Its principal current does not at first take a direction towards the defile, but flowing round the bottom

of the *combe*, it has attacked the foot of this *schistose* eminence, in which it has made an excavation, because the *schistus* easily crumbles down; and at the point where the river bends its course to enter the defile, these attacks are still continued. Now this stream, proportionally as it has extended itself into the lower part of the *combe*, which is likewise excavated by it, has withdrawn from its ancient bed, where there is at present a large tract of alluvial soil, composed of sand and gravel. These, then, are the only materials which have been brought down hither by the *Bober* in its greatest swells; and in its present inundations, though still sometimes sufficiently considerable to cover the greatest part of this soil, it no longer deposits any thing but sand, on which as yet I saw no grass but in the parts most remote from the course of the river. This operation will be continued; and by degrees, in consequence either of the accumulation of the sand in parts still nearer to the stream, or of the reduction of the latter to a lower level by the widening of the entrance of the defile, there will be a greater extent of ground beyond its reach, and in a state proper for tillage. This has already occasioned the erection of a *mill* called *Neu-mühl*, which has been too recently built to have obtained a place in the maps, and around which some cultivation is carried on. This is a kind of *chronometer* common along most of the great rivers in mountainous regions.

575. The *Bober*, after having entered this defile, continues to flow between hills, but makes a wide turn to the left; which induced me to cross the hill bordering the combe on that side, that I might recover sight of the river beyond it. This hill belongs to a ridge, the upper part of which is all cultivated on a soil consisting of rubbish of *gneiss;* and in ploughing, *blocks* of that stone are taken out; nor is this surprizing, for the mass of the hills is in this part of *gneiss*. But among these *blocks* there are some of *granite*, although this ridge is separated from the granitic region by the large *combe* which I have described; and here I began also to observe *blocks* of *white quartz*. Now therefore I had entered a country where the *scattered blocks*, in part at leaſt, are extraneous to the soils on which they lie; yet I had followed from the mountains the only streams capable of transporting these masses without perceiving that any were propelled by them; and on the bed of the *Bober*, every appearance of such an operation will be found to cease.

576. In proceeding along this road, I crossed another large *combe*, descending, like the former, from the top of the hills to the bed of the *Bober*, which here also has gained by degrees on the lower part of the open space, retreating, at the same time, from the opposite side, where a horizontal soil has been formed, similar to that already mentioned as opposite to the other *combe*. This phenomenon, which, as I have said, occurs very frequently in all

mountainous countries, evidently proves that *combes* and *vallies* are effects, not of the action of *running waters*, but of catastrophes of the *strata* antecedent to the birth of the continents; since streams are so far from having ever been able to produce these interruptions of the continuity of the strata, that their only operation has been to raise and level all low spaces which have lain in their course, and in which they have found room to spread.

577. When I came to the border of this second *combe*, I saw the *Bober* issuing from a defile on the left, and afterwards flowing in a strait wide bed which extended a considerable way to the right: throughont this whole space, though the water was not deep, its surface was smooth, because there were no *blocks* on its bed; nor below this did I see any more on the course of the river. At this point it quits the mountains, and no longer flows but between hills; how can it then be supposed to have carried any stony masses on to the plains, when none are found on its bed, after it has issued from the passages where *blocks* have fallen from its sides? Here I went down to the bank of the *Bober*, and coasted it, till I came to a very large horizontal space, which, when much swelled, it still overflows, and in which it divides itself into several branches that change their places during great inundations; as obviously appeared from the sand and gravel covering the whole space. This is a circumstance which very commonly occurs in the great vallies of

the *Alps*, if no prospect of advantage has induced the inhabitants to employ the times when the rivers are low, in deepening their beds, and raising their banks with a gentle slope, in order to form for them permanent channels. That operation has been performed in many places, where the soil levelled by the waters has happened to be covered with a sufficient quantity of sand, either to form meadows, or to become fit for tillage: in the latter case, villages have been built; and when wells are sunk for the use of the inhabitants, the history of these soils, and consequently of the river itself, may legibly be seen. Below the sand, of which the stratum varies in thickness, is found small gravel, increasing in size proportionally to its depth; under this there are stones; and these likewise are larger and larger, till the original bed is reached, on which the river made its first deposites. In my Travels already published, I have described this succession of materials, progressively increasing in size from the top to the bottom, in the *alluvial soils* of several rivers. The extensive space over which the *Bober* thus wanders has no large stones on its surface, but there is not here sand enough to form a soil fit for any use, and the river is therefore allowed to follow its own caprices; before it enters this space, it is made to pass over a sloped dike constructed of basalts, which obliquely crosses its course, and carries a part of its water into a canal that leads it to some mills at *Mauer*.

578. It was near noon when I arrived at these mills, which were on the right bank of the river; and I stopped at them to rest my guide and my horse. I found the miller a sensible and obliging man, who was very ready to answer all my questions, though it gave us both a great deal of trouble to understand each other. I chiefly inquired of him whence the stones had been brought for the dike; and he shewed me, on the top of the hill along the foot of which I had just passed, an eminence entirely composed of them, called the *Schlossberg* or Castle mountain; but he told me that it was not necessary to fetch them from this eminence, because the slope below it was completely covered with them, and there were likewise great numbers in the soil of a vale descending towards *Mauer*. This honest man was going to dinner with his family; he invited me to sit down to table with them, which I was glad to do; and when, at my departure, I inquired what I was to pay on account of my horse and my guide, he rallied me for the question; saying that when people were wandering about the country, as I was, they must not expect to meet with *public houses* in their way.

579. Beyond this, the hills change their nature; they are no longer either of *granite* or of *gneiss;* but the *Bober* continues to wind, for some way, between eminences composed of *argillaceous schistus* and of *sand-stone.* According to the note which M. Frederici had given me, I was to observe, be-

yond *Mauer*, some very singular quarries of *mill-stones*. On leaving that place, I crossed a hill, and came down on the side of a valley opening near a village called *Walterdorf* into that of the *Bober*. When I arrived within sight of this valley, my guide led me to the right, towards the *Mühlstein-bruch*, (mill-stone quarry,) which is sufficiently remarkable to be indicated in the maps. We first entered a wood, where I fancied myself again in the *Giant's mountains*, on account of the quantity of rounded *blocks* of immense size, which were so much covered with *lichens*, that it was some time before I could discover their nature. The farther I advanced, the more I was surprized at the abundance of these *blocks*; and at last I came to a spot where there were no trees, because there was no longer any space in which they could grow; these masses being here accumulated in a manner scarcely to be imagined but by those who have seen similar instances; and this was the place of the *mill-stone* quarries. These vast *blocks* consisted of a hard white *sand-stone* with a shining grain, in which I saw impressions of large *pectines*; they must therefore have belonged to *strata* formed in a continuous manner on the bottom of the sea.

580. The cause of the production of these *blocks* very evidently shews itself. The *valley* was formed by a great *subsidence* of the strata of this stone, which, at the same time, were shattered; and abundance of the fragments having remained on the slope, their angles have been gradually worn off by decomposition;

since that period, as surfaces of greater extent are not attacked by atmospherical causes with equal advantage, they have been overspread with *lichens*, which is commonly also the case with *granite:* the sections of these *strata* are seen at the top of this side of the valley, under a very thick loose soil. In following this side, I came to a projecting rock, which, being of the same nature, is likewise worked for *mill-stones*, and is besides used for hewn stones. Here, though, from the *marine bodies* contained in this stone, no doubt can be entertained that it must have been deposited in *strata*, on the bed of *the ancient sea*, I found its strata as difficult to be distinguished in the rock, as those of some kinds of *primordial stones*, of which the stratification has been questioned; for I saw lines nearly horizontal, intersected by others almost vertical, those in each direction being parallel with each other. I endeavoured to find some *pectines* in the front of this rock, because the direction of their plane would have indicated that of the *strata;* but I could not perceive any.

581. These *strata* of *sand-stone* were formed at a level much higher than that at which they are found at present; and the masses now constituting the *hills* did themselves subside in part, at the time of the *rupture*, and of that greater *subsidence* whence the *valley* resulted. This may easily be judged by the side of the latter opposite to the quarries, where, on a summit nearly of the same height

with that on which I stood, a pyramid rises, and presents to the valley the section of its *strata;* they are of the same stone, except that their colour is reddish, and they contain the same *pectines;* but there are among them *strata* of *breccia,* in which the imbedded masses are of *granite.* M. Frederici had shewn me fragments of the stones on both sides of the valley, thus differing in colour, but containing the same shells, and had described to me the spots in which he had found them; I could not go to these spots, because a shower came on before I quitted the quarries, and soon became very heavy; however I went down to the bottom of the valley of *Walterdorf,* to see the *Bober,* issuing from its own valley; at this point, it was flowing calmly on a bed composed merely of *granitic sand,* and very small *gravel* of the same nature; but a little below, it was bordered by hills of different kinds. I continued for some time to follow its right bank along the foot of the eminences composed of the *strata* of reddish *sand-stone;* I often saw the sections of these strata, which were very much inclined, and consequently passed beneath the soil of the valley. I then returned, over a bridge, to the left bank, where I found myself on a hill of *argillaceous schistus,* abrupt on the side towards the *Bober.* Of this part of the valley, therefore, the opposite sides are again very dissimilar; so that it manifestly cannot have been cut by the *river.*

582. The summit of these *schistose* hills is cultivated: along the sides of the fields, I saw *blocks* of *granite*, which had been taken out of them, and which here it is impossible to ascribe to any cause but the same that has occasioned the dissemination of blocks on hills and plains very remote from all mountains; and we may now be very sure that these masses have not been transported hither by running *waters*, since we have seen that none are brought by those agents from the mountains. As I passed over this hill, I saw the *Bober* flowing for a long way through meadows; on this side, the hills became gradually lower; and I saw no mountains but at a great distance to the right. On the road, I observed some *basalts*, and I remarked, on my left, a small mount covered with firs, which I guessed to be their source; but the rain hindered me from going to examine it.

583. Having descnded to *Bober-Mertzdorf*, a village situated in a vale, I crossed the hill beyond it, leaving on my left *Lahn* and *Ober-Mois*, and went down towards a spot where a *rivulet* passes through a great *intersection* of the strata. This was one of the places which M. Meierotto had particularly mentioned in his itinerary as shewing that rocks had been cut through by *running waters:* and but for the rain, I should have gone to view it nearly; but after all my preceding observations, this was by no means necessary: and besides, the course

of the rivulet itself was alone sufficient to obviate such an idea. As I descended the slope the hill towards *Nieder-Mois*, I saw on it *blocks* of *gneiss* and of *sand-stone;* and blocks of both these kinds are also on the bed of the rivulet, which flows at the bottom of this slope; but this does not appear surprizing, when the state of the neighbouring hills is observed. The opposite hill has on its summit several *eminences*, which, on a small scale, resemble the *Königstein* and the *Lilienstein* on the banks of the *Elbe*, as they bear the same character, and consist of the same kind of *sand-stone;* their upper part exhibits sections of *strata*, with projections and recesses, which, from a distance, resemble the walls of ancient castles; and below these rocks are slopes of sand descending to the foot of the eminences. I passed between two of them, rising in fields, not far from each other; it cannot be supposed that any *stream* can ever have flowed on the highest ground in the country to separate these rocks. On this ridge of hills, I saw the commencement of that kind of sand which forms the soil of the vast heaths of the north of *Germany*, where it has buried beneath it the ruins of *stony strata* of various species: I shall soon have occasion to speak of it more particularly.

584. On arriving at *Löwenberg* at six in the evening, I had the agreeable surprize of finding there Baron Von Gersdorf, who had so exactly calculated the time which I should employ in my journey,

ney, that he had arrived at this place only a few hours before me: he had been desirous to see me after the completion of my excursion in the mountains, and especially because he had feared that the heavy rains must have prevented me from observing all the objects which I had wished to examine. The weather, however, had been less unfavourable to me than he had supposed from its appearance at *Mäffersdorf*, on the exterior side of the mountains; and I had the satisfaction of communicating to him all my observations, describing the places which I had visited in the same manner as I have done above: he perfectly recollected them, and agreed to the exactness of my descriptions, as well as to all the consequences which I deduced from them in opposition to the opinions of M. Meierotto; and I am hence the more fully assured that my account of this part of my journey is entirely accurate. As the Baron meant to return the next day to *Mäffendorf*, he rose in the morning as early as I did; and it was with very great regret that I took leave of him, when we quitted *Löwenberg* by our different roads.

June 24th. Having again taken my chaise at this place, I set out at 5 o'clock for *Buntzlau*, two miles distant, and arrived there at eight. As I quitted *Löwenberg*, I saw the *Bober* flowing calmly on a bed of granitic sand and small gravel; these therefore are all the materials which this river has brought down from the mountains, and they will be found to disappear gradually on the lower part of its course. Beyond this the hills were covered with strata of the *heath-sand;* but some of them shewed very evidently by exterior signs that they consisted within of ruins of *stony strata,* which lay at a greater or less depth below the surface, the form of their outline being even determined by masses of *strata* of the same *sand-stone* whereof the hills at so small a distance are externally composed; for the fields are on terraces, one above another, and their soil, consisting of sand, is supported at various levels by long rocks of the *sand-stone,* which form a kind of walls.

585. I set out from *Buntzlau* at a quarter past nine for *Sprottau,* five miles distant; and I arrived at the latter place at three quarters after four. I had now entered those *sandy* countries where *firs* are succeeded by *pines,* and fertility gives place to barrenness. Here I saw *blocks* in some places, together with abundance of those particles of *white quartz* which I have frequently mentioned as belonging to this *sand;* but as yet there were no *flints;* and the *stony strata,* wherever they rose in small rocks above the sand, consisted of a yellowish *sand-stone,* little indurated. Having passed through the village of *Baudendorf,* I crossed a forest of *pines,* where I perceived no *blocks* in the *sandy* soil; it was, however, apparent that there must be some in the neighbourhood; for, in crossing the bridge at *Sprottau,* I saw many large *blocks* laid on the planks

on both sides, in order to render it more solid by their weight. At this place, while I was waiting for the horses, I went down to the *Bober*, and found that almost the whole stream was here led by a canal to supply some mills: that part of its bed which was thus left dry consisted entirely, to a great depth, of *granitic sand* and small *gravel;* this was taken out to gravel the roads, and for other uses; and I saw large heaps of it on the bank, out of the reach of the river when most swelled. I mention this circumstance here, on account of what will be seen lower down on the course of the same stream.

586. At six, I set out from *Sprottau* for *Sagan*, at the distance of two miles, and arrived there at a quarter after eight. Having crossed the bridge above-mentioned, and ascended the hill on the left side of the river, I discovered the source of the *blocks* which I had seen on the bridge: for though, on the other side, I had perceived none in any part of a wide space extending from the top of the hill down to the bank of the river, yet here I found the whole summit strewed with a great abundance of very large ones; the fields were enclosed with those which had been taken up in ploughing, and which, in some places, were set up in double rows. Great numbers of these *blocks* had been of too large a size to be removed without first splitting them with gunpowder; and in the above enclosures, I saw many of the larger fragments, with their sides re-

cently fractured turned outwards; now among these I observed several fine species of *granite* and of *gneiss*, of which I had perceived no vestiges in the strata of the neighbouring *mountains.*

587. On my arrival at *Sagan*, I went down to view the *Bober*, which flows at the bottom of the town, and having been joined by the *Queis*, is here increased to a considerable size; but though this place is only ten English miles from *Sprottau*, where, as I have said, there is on its bed a great thickness of the detritus of *granite*, both in *sand* and in fine *gravel*, I saw scarcely any thing in this part except the common *sand* of the hills, with its usual laminæ of *white quartz.* Thus all transportation of the small quantity of materials which the river has been able to put in motion, in its course from the mountains, is here nearly at an end, and its waters no longer carry with them any but such as it detaches from these lower parts of its banks, which it still attacks in some places, when it happens to be swelled. It was half past nine in the evening when I set out from *Sagan* to *Naumberg*, at the distance of three miles: I lost nothing by travelling this stage at night, for no particular object of attention had been noted in it by M. Meierotto; and I had foreseen what I found to be the case, that the road lay the whole way over *sandy* hills: I reached the latter place at two in the morning.

June 25th. I set out from *Naumberg* at 4 o'clock for *Croſsen*, distant three miles; and I arrived there at a quarter past ten. The first part of my road lay through a forest of pines in loose sand, in which, and some way beyond it, I perceived scarcely any *blocks*, and very few smaller masses. But within a league of *Crossen*, where there is a slight inflexion of the ground, in which a village is situated, I began to see some; and I afterwards observed a great many of very large size, throughout the rest of the stage. Thus the grand circumstances of the phenomenon of the *scattered blocks*, namely, their abundance in certain spaces, betwixt which there are intervals where none are to be found; and the difference, in this respect, between the opposite sides of the same *vallies;* (evident proofs that they have not *migrated* from any quarter, but have been thrown out from beneath in the very spots where we now see them;) these circumstances, I say, together with the other, not less important, which I have shewn above, I mean the *specific* differences between the *blocks* and the *strata* of the neighbouring eminences, may be observed immediately from the foot of the *mountains;* and this deprives the hypothesis, that these *scattered masses* have proceeded from the latter, of even the most distant appearance of probability.

588. It is at *Crossen* that the *Bober* unites with the *Oder*, the largest of the rivers which issue from these mountains; and here M. Meierotto had de-

sired me, in his itinerary, to observe, that the *gravel* of the *Bober* was mingled with *pulverized granite.* He had expected that I should find in this circumstance a confirmation of the opinion which he held in common with other geologists, that the immense quantity of *sand* spread over vast tracts of country, beyond the precincts of these mountains, proceeded from the *trituration* of *granitic* masses by their streams. That this is an illusion may have been already comprehended; but I did not the less attentively examine the phenomena which were in any manner connected with the subject.

589. The *Bober*, as it straitens and enlarges its bed between the slopes of mountains covered with *granitic sand* mingled with *blocks* and smaller fragments, propels along its course a considerable quantity of this *sand*, which it grinds to powder as it violently beats against the *blocks*, in parts where they obstruct its channel. In these parts, I saw on the banks, wherever the river had retreated from them to a lower level, a *white powder*, as fine as the most minute *sand* of these countries; and knowing this to be one of the points which were in question, I took up some of the *powder*, in order to examine it more at my leisure. At *Sagan* especially, where this *pulverized granite* cannot be distinguished from the *sand* of the country, with which it is mixed, except by its superior *whiteness*, I took up some of the mixed sand; and afterwards, observing certain of the sandy *strata* in the hills that were no less

white than the *granitic powder*, I took likewise a little sand from thence. On my return to *Berlin*, I examined all these *sands* with one of my friends who had an excellent compound microscope; and we were both struck with the proof which they afforded of the accuracy of M. de Saussure's remark on this subject. That naturalist had also compared, in the microscope, the *white powder* found on the banks of the torrents which descend from the *Alps*, near the coast of *Nice*, with the *sand* of the sea on that coast; and, in his account of this comparison, he declares that it fully confirmed the system which I had founded on other phenomena, in my *Lettres sur l'Histoire de la Terre & de l'Homme;* namely, that the *sand* covering such vast tracts of country, and similar to that on the *bed of the sea*, is the latest of the chemical *precipitations* which took place in the *primordial liquid.* With the *microscope* it is impossible to mistake the difference between the *sand* of the *sea* or of *sandy* countries, and the finest *quartzeous powder* propelled by torrents; we observed, like M. de Saussure, that the most minute grains of the latter were in general *angular*, and that the surface of such as were the most rounded was *ground*, which rendered them *opaque*, and shewed them to be the product of a *detritus;* while the grains of the true *sand*, very irregular in their form, were *transparent*, and *polished* even in their *cavities;* characters which evidently belong to *natural bodies.*

590. Thus then it is only with a small quantity of *pulverized granite*, added to the *sand*, of the country, that the *Bober* arrives to join the *Oder*, which itself brings down hither nothing but this *sand*, having already wound for some way between hills of the same nature. The former of these streams, before it reaches the point of their junction, flows in a very wide vale, where, during its inundations, it has formed *islands of sand*, which, as no grass yet grows on them, it must evidently still cover when greatly swelled; and it then spreads itself also over the pasturages occupying the rest of the bottom of the vale. The two rivers, when united under the name of the *Oder*, flow together at the foot of the hills on the right bank, which are planted with vines; and on the left bank there are extensive pasturages, inundated, like those above, whenever the river overflows.

591. At 1 o'clock I quitted *Crossen* for *Zibrigen*, at the distance of 3 miles, and arrived there at a quarter after 5. At first setting out, I crossed the *Oder*, as I was now to travel over the hills on its right bank. Here likewise the bridge is loaded with *blocks* on the side on which the river arrives, that, by this additional weight, it may oppose more resistance to the current; some of these were only splinters of very large *blocks;* and I again observed, in their recent fractures, several fine species of *granite*, none of which I had seen in the mountains.

592. As I travelled over these hills, a great extent of the course of the *Oder* lay within my sight; and on its left bank, I had a complete view of one of those chronometers which are found along all rivers flowing between sandy hills: on the sides of rivers in mountainous regions there are likewise chronometers of various kinds, as I have already shewn; but this class is more simple, and more strongly marked; I have already pointed it out on the course of the *Elbe;* but I shall here describe it with farther particulars.

593. The *Oder*, towards which the eminences on its right bank slope gradually down, is in this part bordered at their foot with a great breadth of meadows; its current having here borne against the opposite bank, which rises in abrupt hills. I could here see a great extent of these hills; at both the extremities of the tract within my view, their rapid slopes were covered with wood, and descended to the edge of the river, which did not there attack them; the higher extremity, being on the side whence the stream arrives, was above the point where it comes up to the foot of the hills; and it bends its course before it reaches the lower. Several promontories however in the interval, composed entirely of *sandy strata*, have been attacked by the *Oder*, which, by sapping their foot, has occasioned them to crumble down; and they are now, consequently, reduced into *cliffs*. I could easily trace all the stages of this operation. Some cliffs of the

most projecting promontories were still crumbling down from top to bottom; some continued to crumble only in the upper part; while others were converted into smooth slopes covered with grass: at the foot of the latter, the river was kept off by a beach composed of the stones which had fallen from above. All the *sand* thus falling from the hills sapped at their foot by the *Oder* is carried down its course when it overflows, and formed into *alluvial soils*, wherever its waters find space to spread. Such is the origin of the wide and extensive alluvial soil at the bottom of the hills, opposite to the cliffs, over which I was now travelling.

594. As I proceeded along the top of these hills, I remarked another chronometer of a kind that has always attracted my attention in travelling through countries naturally barren, as is the case with these of sand, of which the only spontaneous product is heath, and with respect to which I have entered into many details in my *Lettres sur l'Histoire de la Terre et de l'Homme;* this is the *progress* of *cultivation*, in situations where so little profit can be gained by it, that much labour is required to oblige the earth to yield to the husbandman even a scanty subsistence. In these countries may be observed certain *central spots*, which are those where the first settlers fixed their habitations, and whence cultivation extended itself, as their families increased. But where the land was very unproductive, and there were no means of procuring manure, if the numbers

of the settlers greatly multiplied, and their villages became too large, they found themselves obliged to go to an inconvenient distance to till lands which yielded so small a return: hence they were led to form new settlements, some way off, for such of their children as were of an age to work; building cottages for them, assisting them to clear the ground, and furnishing them with the first requisites for labour, horses or oxen, and instruments of agriculture. These were at first *hamlets;* but by degrees they became *villages* like the former, and were consequently new *centres of cultivation.* As I passed along the borders of a forest on these hills, I saw some new settlements, which, from the small size of the trees in the orchards, and of those planted in the inclosures, did not appear to me to have been formed above seven or eight years; but there were already around them crowds of children, keeping cows on the skirts of the forest, and geese or hogs on the heath. I afterwards saw the probable source of this new population, in a village which the growth of its trees shewed to have been inhabited not less than from five and thirty to forty years; and here the surrounding soil was much improved in fertility. In this manner I have traced the *progress* of cultivation on heaths, in all my numerous journeys, during a period of 35 years, through different parts of the north of *Germany.*

595. I set out from *Zibrigen,* at three quarters after 6, for *Frankfort,* where I arrived at 10 o'clock,

the distance being 3 miles. The road continued over these barren sands interspersed with forests of pines, where, for a long time, I perceived no *blocks;* but after having passed a slight inflexion in which a a rivulet flows, I saw a great many on the opposite slope; they did not, however, extend far on the summit of the hill; and after I had again entered some pine-woods, I observed no more.

596. Around the spot where *Frankfort* is situated, the *Oder*, which is subject to great inundations, has found a large space to spread; this space, having been levelled by its sediments, is now covered with meadows, but is still overflowed when the river is greatly swelled; so that it has been found necessary to make here a raised causeway, with many arches, at various distances, which serve to carry off the waters during floods across this whole space, extending from the foot of the hills to the high ground whereon the city is built. The causeway is terminated, on the side nearest to the town, by a bridge over the common course of the river; this bridge is likewise loaded, along both its sides with large *blocks*, that it may resist the effort of the stream against its piles. From this place, the *Oder* flows on very slowly to the sea between large *islands* which are composed of its sediments, and divide its stream into several branches; while sometimes it passes through *lakes* formed in the cavities originally lying on its course, which it is tending to fill up. These new soils have diminished the extent of an

original *gulph*, described in the first volume of my Travels lately published.

597. As I had now quitted the region of the mountains, and as my road back to *Berlin* was to lead me away from the course of the rivers which proceed from them, I determined to pursue my journey during the night. I therefore set out from *Frankfort*, at a quarter after 11, for *Egersdorf*, at the distance of 4 miles, and arrived there at half past 6 in the morning, having travelled the whole way through a country consisting of *sandy* plains and hills, like those of which I had already, in all directions, passed over such extensive tracts.

June 26th. I set out from *Egersdorf* at 7 in the morning, and arrived at *Vogelsdorf*, distant 3 miles, a little after mid-day. In the first part of this stage, I saw no *blocks*, either on the uncultivated grounds, in the woods, or along the sides of the arable fields; but having passed an inflexion of the ground, and crossed a rivulet which flows at the bottom of it by a bridge built of large masses of the finest *granites*, I afterwards observed *blocks* all the way to *Vogelsdorf*; many of them were *angular*, being of species not liable to decomposition; and there were quantities of smaller fragments of beautiful *granites* and other kinds of *primordial stones* of which I had seen none in the *Giant's mountains*.

598. As I was passing over the hills, nearly a mile from *Egersdorf*, I came to one of those *lakes*

which occur on the course of the *streams* in this country, where the waters flow with so little declivity; this first *lake* was small; but towards the end of the stage I saw one on the right, which extended as far as *Tasdorf*. The streams passing through these *lakes* fall into the *Spree*; and in my Travels already published, I have described the *lakes* on the course of that river, as well as those formed by the *Havel*.

599. At 1 o'clock, I set out from *Vogelsdorf* for *Berlin*; the distance was 2 miles and three quarters, and I arrived at the latter place at 4 o'clock, thus terminating a very interesting excursion, in which I had employed 26 days. In this last part of my road, I met with nothing worthy of mention; the soil of the country consisting entirely of *sand*, mingled with its usual particles of *white quartz*, and various kinds of *flint*; and there were also *blocks* of *granite* and other *primordial stones*, which *abounded* greatly in some places, and were very *thinly scattered* in others.

JOURNEY *from* BERLIN *to the country of* BAYREUTH, *and return through* BOHEMIA.

SEPT. 8*th.* 1799. The preceding year, I had followed, from *Berlin,* the trace of the *blocks* of *primordial stones,* with the phenomena attendant on them to the *Giant's mountains,* which are composed of these stones. In my present journey, one of my objects was to follow this trace, so essentially characterizing the nature of the revolutions undergone by our globe, from the same place, but through different countries, to the mountains of the *Fichtelberg*, which are in the territory of *Bayreuth,* and form in a part of their length the boundary between *Saxony* and *Bohemia;* it being my intention to return afterwards, through the latter country, into *Saxony.*

600. On this day, I set out from *Berlin,* and went first to *Potsdam,* at the distance of 4 German miles. I again observed, on this road, the great abundance of large *blocks* which I have elsewhere mentioned as very remarkable, since they consist of *hornblende*

mixed with *feld-spar* of a *bright red*, and are peculiar to this part of *Brandeburg*. Near *Potsdam* I crossed the *Havel*, that river which has on its course so great a number of *lakes*, and which, for this reason, became, a few years after, one of my objects in the Travels that have been lately published.

601. From *Potsdam* I set out for *Belitz*, which is the next stage on this road, and is at the distance of 2 miles. I here entered on arid sands, everywhere agitated by the winds, except in the parts where they are covered with pine-woods, or with a thin turf. Having again crossed the *Havel*, I saw on its banks a cliff which was crumbling down, being the foot of a sandy hill still exposed to the attacks of the river during floods. I could plainly discern that the very regular *sandy strata* of this cliff had participated in the catastrophes of the *stony strata* upon which they had been formed; for they were strongly inclined, turning their planes towards the higher part of the course of the river. In this road, I coasted a small *lake*, not yet filled up by the *sand* which the waters bring down into it after inundations. There were *blocks* by the way-side, but not of the species so abundant on the hills between *Potzdam* and *Berlin;* these were of *granite;* and I saw a great quantity of them collected together at *Belitz.*

602. The following stage was to *Treuenbrietzen,* distant 2 miles. *Belitz* is situated in a vale consisting of meadows formed on the sediments of a

brook flowing this way to join the *Havel.* My road at first led me up a hill, the slope of which was cultivated, as being in the neighbourhood of this small town; but the upper part consists of nothing but loose sand, interspersed with woods of pines. Hence I descended into a very fertile vale, part of which was in tillage, part in hay-fields, and the rest in pasturage. Beyond this vale, where the soil had been enriched by the sediments of the waters, I crossed another hill, and again saw nothing but pines and loose sands, till I went down towards *Treunbrietzen.* For some way, I saw *blocks* along my road; but afterwards these disappeared, as did even their smallest fragments, and I saw no more till I approached the town. My last stage this day was to *Wittenberg*, which was at the distance of 4 miles, and night overtook me before I arrived there: the country consisted of hills and plains; there were still loose sands and heath, but a great deal of the land had been brought into cultivation. *Blocks* of *granite*, and other stones of the same class, lay here in great abundance, and I had nowhere else seen any so large on this side of the country of *Bremen.*

Sept. 9th. From *Wittenberg*, which is on the right bank of the *Elbe*, I crossed that river, and proceeded to *Düben*, at the distance of 4 miles. In relating my return from this journey, I shall describe the *Elbe* on the *Wittenberg* side; but at present I shall confine myself to its opposite bank, which presents an example of the principal effects of such rivers as frequently flow between *sandy* hills: I have already described these effects in several parts of the course of the *Elbe*, and likewise, towards the end of the preceding journey, on that of the *Oder;* but as this is one of the grand features of the *history* of our *continents*, I shall here repeat its chief characters, before I proceed to give a new example of them.

603. These rivers having at first invariably followed the line of the lowest grounds which lay on their course, passed, in some places, between *sandy* hills; whence resulted three classes of effects:—1st. They attacked such of the promontories of these hills as opposed their free passage, and sapping their foot, occasioned the crumbling down, not only of the strata of *sand*, but of those of *marl* and *clay* which happened to be interposed between the former; and these materials, falling on the beds of the streams, were carried along by their current.—2dly. These rivers in some places, met with low soils of the same nature, over which, during their inundations, they had room to spread: they *levelled* these soils, especially when their waters were raised up in waves by the wind, beating down all the small eminences, and depositing new materials between them.—3dly. and lastly, wherever their current was much slackened on entering any wider space, these rivers deposited on their shores the sand and other minute materials, which cannot float in water, unless it possesses a certain rapidity.

604. At the time when these rivers commenced the two last operations, the declivity of their beds was not uniform; certain horizontal spaces were succeeded by others which were rapid; and the current carrying down the sand from the higher parts, the general level of the bed was thus gradually lowered. There were also some bars of sand, which, by keeping the water above them at a greater height, caused it to encroach the more on the low soils on its borders, and consequently to level them to a farther distance; but these bars having by degrees been carried away, the water of the whole river has a little sunk, and wide tracts of *levelled* ground have been left above the reach of its inundations, except in very extraordinary cases.

605. The rivers of these countries would have everywhere raised, by their sediments, the soils over which they had sufficient space to spread; and in consequence of the gradual lowering of their level, their banks would have assumed such a declivity, as in time would have been overspread with grass, while the water was low, and thus guarded against the attacks of the current; but these operations have been impeded by the labour of men: the alluvial soils which are formed along these borders being too fertile to be left only as meadows more or less exposed to inundations, the owners of the land have in most places enclosed them, in order to convert some parts into hay-fields, and to bring into tillage

those tracts where the sand bears a sufficient proportion to the rest of the sediments to render them fit for the plough. Wherever any settlements therefore have been formed, these soils have been enclosed with dikes; and the rivers have consequently been prevented from making permanent banks, with grassy slopes, over which the water would only have risen to a greater or less height, without attacking them; in some places however, where the alluvial soils are not so broad as to be worth the expense of enclosure, banks of this kind have been formed.

606. Thus, wherever there happen to be low grounds of a certain extent, towards which the hills descend with a gentle slope, soils of three distinct kinds succeed each other on the banks of these rivers: on the immediate borders of the stream are the *alluvial soils*, that is to say, those composed of the *sediments* which it has deposited on its own original bed, whereof, consequently, the breadth is contracted: next to these are the soils above its common height, but covered by its waters during floods, and gradually *levelled* by its sediments; and beyond these again is the original land, which, though low, is above the reach of inundations. Soils of the first description are very fertile, because in them the sand is mixed with the marly and argillaceous particles contained in the sediments of the river: the *levelled* soils have likewise acquired more or less fertility, because the most minute of these

particles remain a long time suspended in the water, and are carried on both sides towards its borders: but, in these sandy countries, the original soil, over which the river has never risen, continues barren.

607. This is one of the classes of monuments which *chronometrically* trace the *history* of rivers in sandy countries; and an example of it is afforded by the *Elbe* near *Wittenberg*. This town is situated at the foot of a hill near the right bank of the river; I shall speak of it more in detail on my return from this journey; at present, I shall only say that its lower part is guarded against inundations by a dike; but that the sandy soil formed along the *Elbe* below the town has not been thought worth the expense of enclosure: when the river is low, this soil furnishes a scanty pasturage for cattle; during floods, it is passed over on a high causeway, terminating at a wooden bridge over the river, which is here of great breadth, but not very rapid; and this bridge meets the dike of the alluvial soil on the opposite side. After having crossed this dike, I proceeded on another high causeway over the soil within it, which is very wide, and may be distinguished, as well by its perfect horizontality, as by the many ditches that intersect it for the purpose of carrying the rain-waters into the river, through the sluices of the dike. The height of the water in these ditches, and in the principal canals, is always the same as that of the river, except when the latter rises above the level of the soil;

when that is the case, the sluices are closed. This alluvial soil extends as far as the village of *Prata*, at which begins the tract merely *levelled* by the stream while its waters were still unrestrained by dikes: this is less fertile than the alluvial, but much more so than the original land; and it extends the whole way to the small town of *Kemberg* built on the border of the latter, along which are small cliffs, marking the line attained by the waves during inundations, antecedently to the construction of the dikes. In very extraordinary floods, the *Elbe* rises over these dikes, and expanding itself over the two former kinds of soil, converts them into a lake, two leagues in breadth. This had happened in 1773, and again to a still greater extent, at the beginning of the year in which I made this journey: my postillion shewed me a monument of the last inundation, against the church of a village called *Eutsch*, a considerable way within the *levelled* soils; and the line marking the height to which the river had then risen was about four feet above their surface. For this reason, the causeway that crosses the *alluvial soils* is prolonged a considerable way over those which are only levelled; it is paved; and I observed that the waves of the temporary lake, formed during the recent inundation, had in many places attacked it, and carried away the pavement, which was not yet repaired. These are vexatious accidents to persons who inhabit houses near the river; but they are very advantageous to the lands, for I was told that the harvest had this year proved particularly abundant.

608. From *Kemberg*, where I entered on the lands over which the *Elbe* has never risen, I ascended a hill with a soil very full of stones, and by no means fertile. This hill continued to rise, though with many inflexions, till having reached its summit, I came to the edge of a chasm, deep, abrupt, and very tortuous, of which the bottom was covered with wood, as were likewise the sides, forming rapid slopes. In order to render the effects of the catastrophes of the *strata* fully intelligible, without ascribing them to causes which have been in action only since our continents have existed, it is absolutely necessary in geology to assign a peculiar name to this particular class of cavities; and for this reason, from the beginning of my Travels last published, I have called them *combes;* an appellation by which, in several countries, they are distinguished from *vallies* and *vales*, wherein rivers flow; while of *combes* it is the distinctive character that they rise up to the highest grounds, and that consequently they cannot afford a passage to any *streams.*

609. The *combe*, of which I am now speaking, is in fact a kind of forest below the level of the summit of the hills: I descended one of the sides, at first very rapid; but at its foot I came into a small plain, where stands the house of a forester, beyond which, for an hour and a half, I passed through successive defiles, where I sometimes went over the projections of the sides, and sometimes proceeded along the bottom, where nothing flows but a rivulet composed of

the waters of springs. On the road which continued to lead me down the *combe*, I saw a vast quantity of *blocks* of *granite*, some of them nearly 8 feet in length. The ground is here entirely concealed; for in this deep cavity, the shade continually preserves such a degree of moisture, as renders vegetation particularly luxuriant; the sides, therefore, do not crumble down. There is a *pool* on the course of the rivulet, which, consequently, has carried nothing with it out of this *combe;* and when, at last, I issued forth into a plain, I saw the water of the little stream very clear, and flowing on a bed of the same *gravel*, which, mingled with sand, forms, in this space, the poor superficial soil. This, in short, is a chasm of the same nature as those that I described, in one of my preceding journeys, on the borders of the *Elbe;* with only the difference, that this, instead of terminating at the side of a river, opens into a plain. I was still at some distance from *Düben;* but I saw scarcely any more *blocks* in my road; and though the ground continued low, it had little appearance of fertility.

610. I proceeded this day but one stage farther, which was to *Leipzig*, at the distance of 4 miles. In my way thither I crossed the *Mulde*, a river passing through *Düben*, and uniting with the *Elbe* at *Dessau;* I saw it flowing very slowly, because its bed has but a small declivity; and it is so little above the level of the *Elbe*, that the latter, when greatly swelled, overflows the lower part of the vale

of the former, which is on both sides bordered with low soils *levelled* by the river during floods; these are easily distinguished by their fertility, which is greatly superior to that of the succeeding soils, though at a level very little higher: the latter are subject, however, to occasional inundations; and the postillion told me that they had been under water the beginning of this same year. A causeway, which crosses all these soils, extends beyond Düben to a village where the ground rises, and is at first very barren, being partly covered with heath, and partly with woods of pines and birches; but afterwards I found a great change in the scene; for I came to a vast arable plain, extending as far as *Leipzig.* I had never passed over such a plain as this; for as I was travelling on it, I saw it, for a long time, meet the horizon all around; nor did I perceive a single tree, hedge, or bush, except immediately round the villages, which rose like islands in the ocean. Before I came within view of these villages, I could distinguish, on the horizon, the spires of their steeples, resembling the masts of large vessels when they are first descried at sea; by degrees, I gained sight of the steeples themselves, and at last of the villages more or less distant from me; and in the same gradual manner the objects which I left behind me disappeared. The perfect uniformity of this whole tract of arable land has obliged the different owners of it to raise small mounts, of different forms, and covered with grass, that they may be able from a distance to distinguish their own possessions.

611. Here appears a strong instance of the effect of manure and cultivation in ameliorating the most sandy soils. To judge of the soil of this plain from that of the roads, which was of the most barren white sand, it could not be expected to yield such harvests as are really produced here; but the vicinity of *Leipzig*, a large commercial town with meadows near it, has supplied every thing necessary for the fertilization of this soil: in the fields it has become grey, by the mixture of manure, and of the stubble ploughed into it; so that even the parts left as fallows yield pasturage to fine herds of cattle. When I saw this immense extent of corn-land, I was not surprized that *Leipzig* is so famous for its larks, which in winter are sent to a great distance, being first plucked, and very closely packed in boxes.

612. One circumstance which may have favoured the cultivation of so extensive a tract of ground is, that there are here no stones, and I saw scarcely any *blocks;* but the case is different on the other side of *Leipzig*, where there is again a great change in the appearance of the country. This town is built partly in a vale, in which the small river *Elster*, augmented by the waters of the surrounding hills, flows to join the *Elbe* at a considerable distance. The soil of the vale, having been levelled and enriched to a great breadth by the sediments of the stream, is partly converted into meadows and rich corn-fields, and the rest is occupied by fine woods. Many of the intersections of the hills open into this

vale; and here I again found abundance of *blocks* and smaller masses belonging to the *primordial strata:* I saw a number of these *blocks* along the houses at *Leipzig*, and they are broken and used, together with gravel, for mending the roads. These *blocks* are of a brown quartzeous stone which is very hard.

Sept. 10*th.* I set out in the morning from *Leipzig* by the road leading to *Gera*, and my first stage was to *Pegau*, 3 miles distant from the former place. At *Leipzig* begins a causeway which is a league in length, extending across meadows to a village, whence the ground descends to the level of the *Elster*, that river here dividing its stream, and winding through large vales, which it converts into the richest hay-fields and pastures; and this has contributed to fertilize the whole of the surrounding lands to such a degree, that I never saw, in any country, a greater luxuriance of vegetation. Here neither *blocks*, nor large stones of any kind, are suffered to remain in the fields; they are laid along the sides of the road, especially in the villages, which have been greatly multiplied, on account of the number of hands required to cultivate these lands, where the products of the different seasons follow each other in the most rapid succession. Among the *blocks*, I still saw some of *granite*; but the greater part are of the above hard homogeneous stone, which is conchoidal in its fracture, and of which the surface is of a yellowish brown: these masses have retained their angles; but those of *granite* have the rounded form of most of the *granitic blocks* scattered over the countries lately described. The causeway which crosses these meadows is very good; it is rendered firm by large gravel of the same stones, mixed with a fine gravel of *white quartz* which is found in the soil; the whole being covered with a yellowish sand taken out of a particular stratum, at some depth below the surface: for this purpose some large excavations had been made, where I saw the section of the stratum; and the sand resembles that which is found in the southern part of *England*, mixed with abundance of siliceous gravel.

613. My second stage was to *Zeitz*, a small town at the distance of 2 miles. I still continued to travel over very fertile lands, along one of the wide vales covered with meadows, through which the *Elster* flows. This small river rises at the foot of the *granitic* eminences of the chain of the *Fichtelberg*; yet the *blocks* of *granite*, so abundantly scattered in the countries lower down on its course, here entirely disappear, though other *blocks* are found in the loose soil: those which impeded the ploughing of the fields have been taken up, and laid along the sides of the road, or in the villages; but they are all of the brown stone just mentioned: a great deal of gravel of *white quartz* is also found in some particular strata of the loose soil; and the causeway is here covered with it. At *Zeitz*, the *Elster*, which flows along the slope of a hill whereon that town is built, is crossed on a bridge; its bed (like that of all rivers in horizontal

vallies and plains) is not covered with any other stones than such as are contained in the loose soil of the hill at the foot of which it flows.

614. My last stage this day was to *Gera*, at the distance of 2 miles. In setting out from *Zeitz*, I passed through the upper part of that town, from which I soon came down to lower ground; but afterwards I ascended a higher hill. The first slope of the latter is so rapid, that, in order to carry the road up it, a long excavation has been made, in the lower part of which are seen, in the steep sides, sections of the interior strata of the soil, filled with large *blocks* of the *brown stone* with conchoidal fractures, and with *blocks* of *white quartz*, besides a quantity of smaller masses of both kinds; the latter only are rounded, and with them *Zeitz* is paved.

615. There are several ridges of these hills; and from the summit of the second ridge, I had a view of a country very different from that over which I had just passed; it was covered, indeed, with *sand*, but the outlines were much less softened; for it was deeply intersected with *vallies* and *combes*, and their very abrupt sides were cloathed with forests. The mass of these hills consists entirely of *loose strata*, which are principally of *sand*, intermixed with some of *clay*, and present their sections on the sides. All these *strata* are parallel with each other, and in those parts where their sections follow the direction of their planes, their lines appear nearly *horizontal;*

but in the projections, where they are seen sideways, I perceived that they *inclined* towards the interior part of the hill. This is a proof that these *vallies* and *combes* were produced by *fractures* accompanied with the *angular motion* of the separated parts, and extending down to the *stony strata* beneath, the *fragments* of which, during the catastrophe, were ejected, through those *fractures*, over the *loose strata* that covered them. The soil of these hills is much less fertile than that of the preceding; it is in great part covered with heath interspersed with woods of pines and birches, which are always an indication of barren sands. All the *blocks* scattered on the surface are of the hard stone with conchoidal fractures; and in the cultivated parts I saw a great many small masses of *white quartz* and *grey wacke.*

616. I continued to travel over the same soil, across which I found some large inflexions, till I came to the top of the last of these eminences, commanding a view of *Gera.* This town is situated in a *valley* towards which the hills on this side are cut down very abruptly; but I descended thither by a *combe,* beginning at a great distance on the top of the hills. In the rapid sides of this *combe,* covered with forests, like those of one lately described, I saw *stony strata,* of which I had not observed any in the preceding part of this road; they consisted of a grey foliated *sand-stone,* containing a great deal of calcareous matter: these *strata,* which

were here and there exposed to view along a road cut on one side of the combe, had different *inclinations* in different parts of the same side. This *combe* is of great extent, and very wide in some places; but the lower part is so much contracted, and terminates in a *defile* so narrow, that formerly it was closed by a gate, of which the posts are still standing at the point of its opening into the large valley, where a village is situated. When this defile, whence no stream issues but a mere rill composed of the waters of the springs on its sides, is compared with the vast cavity above, the sides of which every where exhibit sections of *stony strata*, it is impossible to consider it any otherwise than as another large *fracture*, in some parts double, and attended by the *subsidence* of the intermediate masses.

617. Marks of similar catastrophes appear in every part of the large valley of *Gera*, which may almost be considered as a *cul-de-sac;* for not far above the town, it is closed by an amphitheatre of hills: it is only through a cleft in these hills that the *Elster* finds a passage into the valley; the spacious bottom of which, having been levelled by the inundations of the stream, is thus converted into meadows, on both sides extending to the foot of the hills, which form the amphitheatre, and are intersected with deep clefts in every direction. These meadows begin at the point where *Gera* is situated on one of the projections of the hills; thus the town

and its castle have a very picturesque appearance. I had taken care to arrive here at an early hour, that I might have leisure to examine the spot.

618. The castle of *Gera* stands on the summit of a rock, on the left bank of the river, advancing in the front of a promontory, from which it is separated by a deep cleft. In order to reach the foot of this rock, I crossed a garden, chiefly on the horizontal soil of the bottom of the valley, and I then ascended the rock itself, by a steep and winding path, paved with *white quartz*, and leading up to the terrace of the castle, round which I walked. I went down afterwards into the cleft, extending as far as to a small lateral valley. Here, on the slope of the hill, I observed the section of shattered *strata* of *argillaceous schistus*, of which I had seen none on the opposite side of the great valley. Both the sides of the cleft are covered with beeches and firs, growing between projecting rocks; and the greater part of its very rugged bottom is overspread with moss; a constant humidity being preserved there by the shade of the trees, and by some small springs which issue from between the strata of the hill. The latter being of considerable height, its summit afforded me a view of all the country lying on this side of the *granitic* chain of the *Fichtelberg*, which I saw rising on my left. This country is interspersed with hills, some with abrupt sides, and covered with wood, others of a more softened form, and cultivated.

619. That I might the better understand the nature of the castle-rock, I descended towards the great valley, following, through the brushwood on its side, the very steep tracks formed by the rain-waters, which, carrying down with them the schistose rubbish, had here laid open the *strata:* these strata dip, and their sections form a kind of steps; but sometimes so distant, that I could not have descended from one to another, unless I had caught hold of the bushes on the sides. I thus reached the horizontal soil of the valley, in a part where it meets the abrupt side of the rock. The surface of this soil, which is very fertile, consists of the latest sediments of the river; but before the latter had ceased to deposit any thing more than mere powder, or *sand*, it had brought down the gravel contained in the loose soil on the sides of the hills, which is seen on the bed that it occupies during the seasons of ordinary rains. But this bed is bordered, at some distance, by dikes, in order to prevent the river, when swelled, from spreading, and attacking the cultivated lands, of which the soil has been formed by its sediments. I was told, however, that, at the beginning of this same year, when, as I have already mentioned, all the rivers of this country had been swelled to a very unusual height, on account of the great quantity of snow which, during the winter, had accumulated on the mountains, the *Elster* had risen above these dikes, and had reduced into a lake the whole of the large valley of *Gera:* but the valley being horizontal, and the water, in

consequence, having scarcely any current, it only covered the springing corn with fresh sediments, and the harvest proved afterwards more than usually abundant.

620. I have already said that, during common rains, this river preserves a permanent bed: it bends ts course below *Gera*, and in one part flows at the foot of the castle-rock; when I was there, however, it did not come quite up to this rock, under which I passed on the gravel. But during very rainy seasons, the *Elster* rises up to the bottom of the slope of rubbish, causes it to crumble down, and disperses its materials, not suffering them to accumulate here in the same manner as in other parts. When I observed this spot, I saw, beneath the section of the rubbish, that of the *schistose strata*, which pass under the soil, with a strong inclination towards a great cleft in the hills above. It is thus that the sections of these *strata* form the surface of the slope that I had descended from the castle; and hence it is evident that the large *valley*, beginning from the *cul-de-sac*, must have been produced by a *subsidence*, accompanied with the *angular motions* of the masses at present forming its sides; a catastrophe which happened antecedently to the birth of the continents. For it may plainly be seen that, since the river has flowed here, its only operation has been to level and raise the bottom by its sediments.

Sept. 11*th*. My first stage this day was to *Auma*, at the distance of three miles. On coming out of *Gera*, I ascended, for some way, the left bank of the *Elster*; and I then entered a combe, very irregular, and at first very deep, it being of the same nature as that by which I had descended to the right bank of the river; and of this combe also the steep sides are covered with firs. When I had proceeded some way up a road on the right side, I looked down on the valley, which lay at a great depth below me. The road being, in many parts, cut in the *schistose strata*, I saw them at first inclining inwards, and turning their sections towards the *cul-de-sac*, which had been the point of the greatest *subsidence*; but, as I continued to ascend, I observed frequent changes both in the inclination and in the direction of these *strata*.

621. I thus arrived on the summit of a ridge of hills, which continued to rise on the left, and which I followed in that direction. It has been seen in the *combe* below that the inferior mass of these hills is of *schistus*; yet on the summit I found nothing but strata of loose soil, superficially mixed with *blocks* and *gravel* of *white quartz* and of *grey wacke*. After having continued to ascend for three quarters of an hour through woods of *firs*, I came to the highest part of this ridge of hills, which is, indeed, the most elevated spot within a great distance all around; for when I had proceeded on it some time, my eye passed over all the neighbouring eminences,

and the horizon was in every part bounded by the sky. Hence I began to descend a slope, extending a great way, but with deep intersections, the abrupt sides of which are covered with fir-woods; and this, as I have already had occasion to observe, is always an indication of sections of the *strata*, because the roots of the trees easily penetrate between them. Farther on, I saw ridges of hills, one behind another, which were all much intersected, and their abrupt sides were likewise covered with firs. These ridges continued rising to the view the whole way to the *granitic* chain of the *Fichtelberg*. Near the top of the slope, I saw, here and there, some rocks of *schistus* rising above the sand, which, lower down, is very deep. The heath and the pine-woods then appeared again, and the cultivated spaces shewed great marks of sterility; I did not here observe either *blocks* or *gravel* of any kind; and this was the case till I reached the village of *Grosse-Ebersdorf*, where was the half-way house. These thick *loose soils* on the highest hills of a country, where they cover the ruins of *stony strata*, to the nature of which they are altogether extraneous, cannot certainly have been produced on our continents since they have existed, but are to be ascribed to the last operations of the sea, before it retreated into its present bed.

622. From *Grosse-Ebersdorf* to *Auma*, the soil is low, and bears all the characters of a great *subsidence* of *strata* formerly continuous with those

which

which compose the surrounding eminences, and of which rocks, in many places, rise above the surface; within this tract, the parts at a certain height are cultivated and fertile; such as are higher are covered with *sand*, and produce nothing except pines and heath; but the lower spaces are grassy, being under water in rainy seasons; and here also springs issue from the sections of the *strata*, and form permanent rivulets uniting in a brook which passes by *Auma* to join the *Elster*. Several rocks of *schistus* here rise above the *sand;* and I found their number increase as I crossed a wood where I saw on the surface, not only a great deal of *gravel* of *white quartz*, but likewise *blocks* of the same nature; some very large ones lay near *Auma*, which is a small town built at the foot of a new ridge of hills.

623. My second stage was to *Schleitz*, at the distance of two miles. In some deep clefts of the hills which I first crossed, I saw the *schistus* beneath the *loose soil*, but in so shattered a state, that I found much difficulty in distinguishing its *strata;* however, I could perceive them to be differently inclined in different places. This situation of the *strata* renders it very unpleasant to travel on these hills, in parts where their *section* forms the surface, while their direction obliquely crosses that of the road; because, when one wheel of the carriage rises, another suddenly sinks, in passing over the edge of a *stratum* more broken than those between

which it lies. I have already described this symptom of subsidences and *angular motions*, on summits composed of *strata* of *lime-stone*, *sand-stone*, and *granite*, as well as on those of *schistus*: it is a very frequent phenomenon, and I shall again have occaſion to mention it. I crossed several ridges of these hills, of which the very stony parts are covered with fir-woods; but those where the loose soil happens to be deep have been brought into cultivation. The intervals of these hills are occupied by meadows, where, in several places, the rain-waters are retained by dikes, in order to form ponds, the water of which is led to supply some mills.

624. From the brow of the last of these hills, I had a view of *Schleitz*, which is built around the extremity of a promontory advancing into the valley from an opposite ridge, and of which a large castle forms the highest part. Into this *valley* likewise, I descended by a *combe*, which on both sides presents sections of the *schistose strata*; and as they incline obliquely towards the interior part of the hill, their sections are also seen on the side of the valley opposite to *Schleitz*. On arriving at this town, I found the promontory, as well as the ridge from which it projects, and which borders this side of the valley, to consist of *schistus* with nearly vertical *strata*. Thus, when the whole assemblage of these objects is considered, no doubt can be entertained that the valley has been produced by a great *subsidence* between two fractures; that the sides have

undergone *angular movements;* and that the promontory of *Schleitz* is only a part of the sunken mass, which has happened to remain at a higher level than the rest.

625. My last stage this day was to *Gefell.* In setting out from *Schleitz,* I passed through the upper part of the town, which extends along the promontory, and continued my road over some hills much intersected: the low parts are here still occupied by meadows on alluvial soil; the summits are cultivated, wherever the loose soil has happened to be sufficiently thick and unobstructed; but some parts, where the surface is broken by many fractures near each other, and where it is likewise incumbered with vast quantities of stones, are entirely abandoned to fir trees.

626. For some years, however, great ravages have been committed in the fir-forests of these countries by a small species of *caterpillar;* an animal particularly destructive to trees of this kind, which not only die when their leaves are devoured, but also become useless as timber, their fibres decaying, and losing all tenacity; so that they are cut down only for fuel; and even for that purpose they are very unprofitable, as they consume rapidly, and emit but little heat. The forests killed by this insect have a very melancholy appearance; from a distance they look as if lime had been thrown over them, being entirely covered with the white webs of

the caterpillars; and as soon as the trees are dead, all their branches are overspread with a grey lichen. These insects had not spared the young firs, still near the ground, which, had the forests been merely felled, would have been left to ensure their renewal; but the *birches* growing among the *firs* had not been touched.

627. There were some large spaces in which the trees thus killed had been already cut down; and it was there that I observed the nature of the soil to be such as I have above described it, with abrupt clefts at little distance from each other, which are studded with rocks, and shew that the strata have undergone astonishing convulsions. It is in soils of this nature that forests are preserved, because, as the plough cannot here be used, the husbandman has no inducement to attack them; and firs being the trees which thrive the best in these countries, great rewards have been offered by the neighbouring governments to those who should find means of putting an end to the ravages of this caterpillar; but I have never learnt whether any such means have been discovered. All these hills are of *schistus;* yet in the loose soil of the surface are found great quantities of *gravel* and of large *blocks*, both of *white quartz* and of *grey wacke;* though neither of these stones appears externally.

628. The small town of *Gefell* is in a valley; and as I wished to examine the adjacent country,

I would not this day proceed any farther. I walked up the valley by the side of a brook flowing through pasture-grounds, where I saw a great many *blocks* of *white quartz;* one which I measured was eight feet in its greatest length. I ascended to the top of the hill by a road very deeply cut in one side of the valley. This road, on both its sides, exhibited the section of a very thick loose soil, the upper strata of which were full of *gravel* and *blocks* of *white quartz.* In my return, I followed the brook for a certain way through pasturages formed on the soils upon which it had deposited its sediments; but the same *blocks* of *white quartz* were everywhere scattered over them; and some of these masses had obliged the stream to bend its course, as it had not been able to move them while it was forming its present bed. This bed, which was about two feet below the level of the grass, was covered with the *gravel* of *white quartz* belonging to the soil, the sand only having been washed away by the brook. Here then we may observe an immediate proof that this valley has been produced by *subsidence;* since on its bottom are found the same stones which prevail on the summit of the bordering hills, and are contained only to a certain depth in the loose strata.

629. From hence I might have gone directly to the *Fichtelberg;* but had I attempted to visit that chain without very intelligent guides, I might have thrown away much time and fatigue to very little purpose. As I had foreseen this before my depar-

ture from *Berlin*, I had addressed myself to Baron Von Hardenberg, Minister of state, with whom I had long had the honour of being acquainted; he had given me a letter of recommendation to the Baron his brother, Grand Ranger of the country of *Bayreuth;* and as this nobleman resided in the castle of *Bayreuth*, I went first to that place, in order to obtain his instructions and assistance.

Sept. 12*th.* Setting out therefore from *Gefell* for *Bayreuth*, (where I arrived in the evening,) my first stage was to *Hof*, a town at the distance of two miles, belonging to the Margraviat. The road continued to lie across successive ridges of hills; and as I approached the chain of the granitic eminences, its intersections appeared to increase in depth. The hills over which I was travelling were all of *schistus*, and their *strata* were in great disorder. I descended to the village of *Teben* by a deep and narrow *combe*, evidently seen to be a great *fracture*, both from its appearance, and because on both sides of it there are several others of a similar nature, and in the same direction. The whole of its slope on the left side, which is very rapid, is studded with rocks; and the fracture having taken a winding course, some lateral sections enabled me to see that the *strata* incline towards a neighbouring *combe;* but *subsidences* having taken place in that which I was now descending, its opposite side, less rapid, and without any projecting rocks, is formed by the plane of the *strata*,

630. I continued to see *blocks* of *white quartz* all the way to *Teben*, and likewise on the slope of a hill which I ascended beyond it; on the hill itself, however, there were no *blocks* but of *grey wacke.* The summits and slopes of these hills are either in tillage, or covered with woods, according to their form, or the nature of their soil. All the low spaces are grassy; brooks or small rivers flow in them; and it is here that the villages are situated. *Hof*, with its gardens, occupies the whole of an almost insulated eminence which rises in one of these vales, and is covered with a thick loose soil; but, as I entered this small town, I saw *strata* of *schistus* at the base of the hill. The *Saale*, which rises among the *granitic* summits, passes near this mount, and flows through meadows planted with trees. I ascended this eminence within the town, and descended in the same manner on the opposite side.

631. My second stage was to *Münchberg*, at the distance of two miles. From the entrance of the Margraviat, the causeways are excellent, and the slopes have been softened as much as possible by cutting deeply into the eminences, and employing the materials taken out in raising the low parts. Wherever these deep cuts have been made in the summits, the *stony strata* have been laid open. In part of the road to *Münchberg*, I saw for some time the *argillaceous schisti*, which were succeeded by *micaceous schisti*, and afterwards, in the ridges nearest

to the *granitic* eminences, by *gneiss*. The disorder of the *strata* in these ridges, and the successive approaches of their nature to that of *granite*, besides an intermixture of *strata* of *sand-stone*, which I shall mention in the sequel ; the *loose soils* covering all these *strata*, and containing *blocks* and *gravels* of *stones* extraneous to them ; and lastly, the much intersected ridge of *granite*, which is bordered by these various species of strata, and towers above the whole ; all these are circumstances most clearly characteristic of an original state of the continents at their birth : for none of the causes in action on them since that period can possibly have thrown *strata*, which were manifestly formed one on another, into these distinct and neighbouring ridges. Thus then it is that *vallies* have been produced ; and it would be a contradiction to obvious facts to persevere in maintaining the hypothesis of their excavation by *running waters ;* since, besides that the true cause of their formation may here so plainly be seen, I have everywhere shewn that these waters have raised the bottom of the *vallies* by their sediments. Nor would it be less in opposition to the evidence of facts, to suppose that the *loose soil* which covers the *stony strata* is the product of the decomposition of the latter by *atmospherical actions ;* for besides its prodigious thickness in many places, and its arrangement in *strata* of various natures differing from those of the *stony strata* beneath them, no existing cause can have brought to the surface fragments,

ments, sometimes so immense, of *stony strata*, which do not themselves externally appear.

632. I had not, for some time, seen any masses of *white quartz*; but I again found them in great quantities on such of these hills as had gneiss for their base. Here also the low spaces are covered with meadows; but the eminences are so much intersected, that only very small rills are formed in their intervals, where ponds have been made to collect the rain-water, and lead it to some mills, during the wet season of the year; but none was flowing at present out of these reservoirs. How then could any blocks have been here propelled by running waters?

633. My third stage was to *Berneck*, at the distance of three miles. In the first part of this road, there were some descents, but more considerable rises; and I at last arrived on ground so high, that it was commanded only by the broken chain of the *Fischtelberg*, which, beginning at some distance on my left, continued to rise before me; but all the country on my right was much lower. This high ground was however cultivated, its soil being very good; but the effect of the elevation of its level in diminishing the heat was strongly manifested by the state of the harvest; at this height, the reaping was but just begun, while in the plain, the crops had long since been carried in. The loose soil was here very thick; and it was mingled with *blocks* of *quartz*

and other hard stones, though there was no mountain in the neighbourhood which rose above it. From the summit of this high ridge begin several deep combes, with abrupt sides covered with firs; and I descended by one of them to *Berneck*. This combe is wide above; but towards the lower part it is so much contracted, that it affords room only for the causeway, between the foot of the right side, and a rivulet flowing at the bottom; the rivulet was at present very clear, and was sometimes lost under the grass which bordered its margin. Wherever the rocks of *schistus* on the brow of the sides of this combe have ceased to crumble down, the slopes of their rubbish are overspread with grass; but this was not yet everywhere the case; for there were some parts where the slopes were too frequently covered by fresh falls of rubbish, to have allowed vegetation to extend itself over them. This is one of the classes of *chronometers* which I have frequently described in mountainous regions, and which may everywhere be found there.

634. *Berneck* lies at the bottom of this combe, and at the opening also of a narrow *valley*, from which issues a branch of the *Mayn* called *Weisse-Mayn*, (or White *Mayn*,) proceeding from the granitic eminences, and crossing the schistose ridges by their vallies. These two intersections of the hills, by one of which arrives only a small rivulet, and by the other a river, converge so much, that, in their lower part, they are separated only by a ledge

of rock, very high and rapid, and terminating above in an acute angle. The ruins of an ancient castle stand on the summit of this promontory, and some of the towers follow its descent. Under these ruins, the rocks were still crumbling down; so that many parts of the slope formed by their rubbish were not yet covered with grass.

635. On quitting *Berneck*, (whence I set out for *Bayreuth*, distant two miles,) I soon came to the opening of a third intersection of the strata, which converges with the two former, and from which issues only a rivulet; and not far beyond this, I saw a fourth, larger than the others, but also converging with them, whence no water proceeds, undoubtedly because the latter (which is another *combe*, and of which the abrupt sides are likewise covered with firs) extends but a little way in the hill; however I perceived, from a bed of gravel at present dry, that, during great rains, or thaws of snow, a small torrent is formed in it.

636. Were it not for these four clefts in the hill, the valley of *Berneck* would here terminate in a cul de sac, of which, indeed, I soon saw it assume the appearance; for, after I had passed these openings, I could distinguish them only by lines of firs. Above them, the right side of the valley is continuous, the upper part being formed by steep rocks still crumbling down; so that on the slopes, which rise to a great height, there were as yet only a few scattered

tufts of grass. These *slopes* have been hitherto prevented from arriving at a fixed state, by the widening and levelling of the high road at their foot. For this road, the slopes have furnished materials in abundance, their mass consisting entirely of fragments; but their base being sapped by the removal of these from their foot, their surface, not yet bound by vegetation, has slipped downwards from a great height; and before it can be secured, by the growth of plants, from farther accidents of the same kind, it must acquire, at a point more remote, the degree of inclination which is necessary for the stability of loose materials.

637. The waters uniting together in the valley of *Berneck* pass under a bridge: when I crossed it, the whole stream was received into a canal cut in the foot of the hills on the left, and led to supply some mills. The natural bed of the river, in which part of it flows during very rainy seasons and thaws of snow, was then dry; immediately below the bridge, it was narrow, and covered with stones; but afterwards it became wider; and I saw it continue to pass across meadows formed on a soil levelled by the sand which the river has brought down in its inundations.

638. If the above description of this *valley* and its branches has not sufficiently proved them to have resulted from *catastrophes* of the *strata* anterior to the birth of the continents, and if the idea of their

excavation by *running waters* can still be considered as entitled to any credit, yet farther objections to that hypothesis will be found in the number of *horizontal* spaces lying on the course of these waters below this point, in which, losing all their rapidity, they have deposited even sand, as is the case in lakes, and where, perhaps, they actually formed a kind of lakes, when they began to flow. At the issue of the stream from the first of these spaces, of which I have just spoken, another, of much larger size, and surrounded with hills, opens on the right, having its bottom covered with meadows on a soil levelled by the sand and small gravel brought down by the river when swelled.

639. The road out of this basin crossed a cultivated hill, beyond which I came again into a low space occupied by horizontal meadows, whence I ascended another hill of greater height, and likewise cultivated, though its slope is very rapid. When, on reaching the summit of the latter, I turned back to view the country over which I had passed, few of its intersections were any longer distinguishable; and the whole appeared to me merely a continuous mountain, cultivated to the height of the fir-woods, which seemed to cover its summit, but which really grew on that of the *Fichtelberg*. But I had before seen that a deep valley separated this chain from the cultivated hills; and on trying to retrace my road, the causeway above-mentioned, which passes over the highest part of the cultivated grounds, enabled

me to distinguish where I had entered that tract, and likewise where lay the *combe* that had led me down to *Berneck*. When I had once determined these points in the indistinct landscape before my eyes, I could also perceive, by a difference of tints, and some slight inflexions marked by lines of firs, the other clefts of which I had observed the openings; and from similar indications, I could easily judge that the rest of this amphitheatre was everywhere intersected in the same manner.

640. The chain of hills over which I was at present passing being much lower than the grounds where I had seen the reapers at work, the harvest was here finished. This chain is of some breadth, but so unequal in height, that I was continually either mounting or descending: when I reached its opposite brow, I looked down into another large basin, rising up to the mountains on every side except that next the town of *Bayreuth*, which lay before me, surrounded with many villages. I found the descent towards it very rapid; but besides that there is an excellent causeway, particular attention has here been paid to the comfort of foot-travellers, and of those who carry burdens. Instead of common mile-stones, there is placed, at every quarter of a German mile, a stone bench, neatly made, and very solid; its front forms an obtuse angle; on each side of which the distances of the principal places lying in those directions are deeply and distinctly engraven. It is a great relief for persons who

travel with burdens along this road, which is all the way up and down hill, to be able, when they come to these benches, to lay down their loads and rest themselves; and foot-passengers, who are very numerous in this part of the country, are also glad to see what progress they have made. The last chain of hills on the *Bayreuth* side is of *lime-stone;* and in this large basin, there are many small hills of the same nature, intermixed with others of *sand-stone;* nor can it be doubted, from the fractures, the disorder, and the various inclinations of these *strata*, as well as from the *blocks* scattered on the surface of the soil, that this low space has been produced by a great *subsidence*, attended with *angular motions* of the sunken masses.

641. I reached *Bayreuth* at seven in the evening, and went immediately to call on Baron Von Hardenberg, who gave me a very obliging reception, and offered to direct and assist me in whatever excursions I might wish to make. The general view which I had taken of the country had suggested to me, in addition to my principal plan of observing the *Fichtelberg*, that of examining some part of this tract of hills consisting of *strata* of *lime-stone* and of *sand-stone*, which, as I have said, commences at the foot of the amphitheatre rising towards those mountains. It had also formed a part of my original design to visit some caverns of the calcareous hills of this country, much celebrated on account of the many *bones of quadrupeds* which had been

found there, and respecting which various conjectures had been formed.

642. Having mentioned to the Baron my wish to observe these different objects, he first shewed me, in a topographical map, the course of both the branches of the *Mayn*, distinguished by the names of *White* and *Red*. It was the former stream which I had crossed at *Berneck;* and I saw in the map that, after issuing from the mountains of *granite*, it flows along lower vallies, where there are several *lakes* on its course. The *Red Mayn*, which passes through *Bayreuth*, has its source at the foot of the *Schneeberg*, the highest of the granitic summits, where it issues from a space which was formerly a *pool*, and is still called *See*, in German signifying a *lake;* this is now filled up; not however with materials brought down by the waters from the heights, but with *peat*. Neither of these two branches of the *Mayn*, therefore, can be supposed to have excavated its *valley;* for in that case it would be impossible that any *lakes* should be found on its course. Now both these streams, on arriving in the plain, have their beds, like those of all other rivers, covered only with the stones which are disseminated in the loose soil of the country, nor have they brought down any others from the mountains.

643. In this part of the country, the names of places as commonly terminate in *reuth*, as they do in *rode* on one side of the *Hartz*, and in *leben* on

the

the opposite side; and in ancient dialects, all these terminations equally indicate lands *cleared for cultivation:* thus *Bayreuth*, or *Beyreuth*, signifies *near the cleared land;* the first ground here brought into tillage having probably been in its immediate neighbourhood: but the whole of this country must have been cleared in very early times, as it is known to have been cultivated by the *Vandals;* and there are even villages in which some traces of the manners of those people may be observed.

644. Baron Von Hardenberg, having considered the bearings of the places which I wished to observe, saw that, as they lay on opposite sides of *Bayreuth*, it would be necessary for me to make two separate excursions for this purpose. It was therefore settled that my first journey should be to the above-mentioned *caverns;* and while I was on that side of the country, the Baron advised me to visit a spot called *Sans-pareil*, which I should find very worthy of observation; afterwards, returning from the *caverns* to *Bayreuth*, I was to proceed to the *Fichtelberg*, whence he proposed that I should go back to *Berlin* by another road, through *Bohemia* and a different part of *Saxony*. My plan being thus arranged, I hired a carriage for the first of these excursions.

Sept. 14*th*. I set out from *Bayreuth* at 5 in the morning, intending to go first to *Sans-pareil*, which was at the distance of 4 or 5 leagues. Not far from the town, I began to ascend hills composed of *strata* of *sand-stone.* After having passed through a village, I suddenly saw below me, on the left, a wide and deep cleft, the steep sides of which were covered with pines, and the bottom with meadows. This is a complete *cul-de-sac*, its upper extremity being absolutely precipitous; and the road passing immediately above it is crossed by a brook, which rushes down into the chasm. I saw several quarries in my way, where the *strata* of the *sand stone*, very much shattered, inclined in different places towards various points. This shews the interior state of these hills, in which great external signs of catastrophes will soon appear.

645. After many alternate ascents and descents, I at last attained the highest point of these eminences. From this spot, the whole country on the left has the appearance of an agitated sea, on account of the abundance of the hills, most of which rise in sharp ridges, with one side abrupt; and wherever their direction was such as enabled me, from the point where I stood, to catch a view of their intervals, I saw that here likewise all the low spaces were covered with meadows: but there is no regularity, either in the direction of these intervals, or in their breadth; the ridges of hills which border them sometimes retire, then advance very near each other, and then again retreat. All these circumstances agree with the idea of *catastrophes*, but in no respect with that of the excavation of vallies by *running waters;* for the

meadows which have been formed here very evidently shew that those waters have raised and levelled the bottom of the intervals with their sediments.

646. To the right of this elevated spot lies *Sans-pareil*, to which I descended by several inflexions of the hills. All these soils are cultivated, and their surface shews the nature of the *strata* which they cover, and in which there is a marked transition, with scarcely any difference of level. The soil of the fields was sandy, so long as I continued on the *strata* of *sand-stone;* but I afterwards came to some other fields where the soil consisted of the rubbish of *lime-stone;* and I soon found that this part of the hills was composed of *strata* of that nature. Some large *blocks* having here lain on the surface, it had been necessary to remove them when the ground was cleared, and they are accordingly laid along the sides of the fields; but though, in the beginning of this journey, we have seen such vast tracts scattered with *blocks* of *granite*, notwithstanding their distance from any *granitic* mountain, yet here, in the immediate vicinity of the *granitic* eminences of the *Fichtelberg*, none of the *blocks* are of *granite*, all being either of *sand-stone* or of *lime-stone*. The most troublesome task, however, to the first cultivators of these grounds was to clear the soil of the smaller masses of stone, every where so greatly abounding in it; and they heaped them up in little mounts, which still remain, being now overgrown with trees or bushes. In this part of the hills composed of

calcareous strata, there are also deep clefts, the abrupt sides of which are studded with rocks and covered with firs, and in which flow rivulets formed by the springs oozing from their sides; one of these little streams, after having wound along the grassy bottom of the cleft, enters the village of *Allersdorf*, through the whole length of which it passes.

647. I was now near *Sans-pareil*, which is a park belonging to the castle of *Zwernitz*, and symptoms of the remarkable nature of this place appear in the approach to it; for the surface of the ground is studded with large *calcareous rocks*, and is even intersected in every part with ledges of their *strata;* but the most remarkable ruins of these strata are within the park, which is planted with beeches on a very rapid slope, and along the top of which is a row of insulated rocks, some of them from 50 to 80 feet in height; many others are also dispersed on the slope among the trees. I left my chaise at the entrance of the park, and one of the keepers attended me through it.

648. The characters above described are common to many places among mountains; but this spot has obtained the name of *Sans-pareil* on account of a particular circumstance. The *lime-stone* which forms the obelisks being mixed with a great deal of *sand*, its surface is easily decomposed by the air; the winds accordingly attack it; and I immediately perceived the effect of their action, having been accustomed to

observe the same in other countries. The wind produces small cavities in the softest parts of the stone; as soon as these have acquired a certain depth, the air forms eddies within, and greatly enlarges them; if the rocks are not of a great thickness, they are entirely perforated in this manner; and the winds then entering the apertures in various directions, and whirling round in them, hollow out within them lateral cavities, like a kind of grottoes. Wherever, likewise, there were originally any fissures in the rocks, they have been widened and indented by the winds; as I have already shewn in the rocks of *granite* belonging to the *Giant's mountains*, and those of *sand-stone* on the borders of the *Elbe*.

649. But in the account of my journey to the *Giant's mountains*, I forgot to mention one of the most remarkable examples of the effects of the winds on the *sand-stone*, which might indeed likewise be called *Sans-pareil* in its kind, and which I saw at *Adersbach* in *Silesia*, whither, in the course of that journey, I had gone from *Schmeideberg*, and where, in the *subsidence* producing a large vale, there was left, in that vale, a rock of *sand-stone* divided by *vertical fissures;* the winds, entering these passages, have so much widened them as to reduce the rock into a group of pillars, which, from the unequal induration of the stone, have assumed various singular forms, and, from a certain distance, resemble large human figures enwrapt in veils. These pillars have continued bare, because the *sand* of the

decomposed stone, as it is constantly accumulating round them, prevents vegetation from spreading over them; so that when this extraordinary group happens to be overshadowed by a passing cloud, while all the surrounding objects are in sunshine, (which was frequently the case on the day when I visited the spot,) the spectator might fancy himself transported to the region of departed spirits. This operation is rapidly continuing; I saw a few blades of grass which had sprung up in the sand, and were already nearly buried by fresh falls. Thus we have here a new *chronometer;* for this rock existed at the birth of the *continents,* and it is since that epoch that the winds have reduced it to its present state, by a *progress* easily calculable from that of the accumulation of the *sand* which they have detached from it. If then the *continents* were at present very ancient, all rocks of this kind would already have been destroyed, as in time they certainly will be.

649. *a.* I return, however, to *Sans-pareil,* where, before the rocks were surrounded with trees, the effect of the winds had merely been to *perforate* them in different manners. These rocks are masses of *strata* that happened to be left at a higher level than the rest during a great *subsidence,* which not only produced the rapid slope now covered with wood, and the lower space contained also within the park, but extended considerably farther in the same direction. Now along the top of the slope, which was the line of the principal fracture, large pieces

of the *strata*, as they inclined towards the point of the greatest subsidence, were stopped in their descent by those below them, and thus remained, with the extremity which had been broken off from the chief mass of the *strata* rising to a considerable height above the level of that mass; and these pieces now form a long row of obelisks on the brow of the slope. Other fragments were stopped at a lower level; but having likewise assumed an upright position, they form similar rocks in the part now covered with wood. The ancient castle, which commands the village of *Zwernitz*, stands on the largest and highest of the upper rocks. Since these masses of strata have been surrounded by a wood, their surface has been overgrown with moss and lichens, which have impeded their farther destruction, except in the cavities, where the winds still circulate, and produce sufficient erosion to prevent the moss from spreading into them.

650. In the embellishment of this park, great advantage has been made of these very picturesque cavities; and with the assistance of art, not only several grottoes have been formed in separate rocks, but, in some places, groups of them have been converted into saloons for various rural purposes, each distinguished by some name appropriate to relative circumstances: on the summit of one of the most lofty of these rocks, which rises above the trees, has been constructed a Chinese pavillion, commanding a view of a very extensive range of hills. Here I

made my guide point out to me in what direction I was to proceed to *Muggendorf*, the principal place in the neighbourhood of the *caverns* which I intended to observe; the ground rose on that side, but was every where equally interspersed with the same multifarious ridges of hills, resembling, from a distance, the waves of a much agitated sea.

651. After having staid nearly three hours at *Sans-pareil*, I set out, at half past 11, for *Wistenstein*, where I arrived at 3 o'clock. The castle of this town is built on a rock that projects in front of a rapid slope, forming one of the sides of a valley through which the road sometimes passes, and which is the great channel of the waters of all the surrounding hills, here uniting in a small river; though there had been rain the preceding days, the water of this river was already clear, for it proceeds chiefly from the springs issuing out of the sides of the *combes*. The bottom of the valley, wide in some places, and narrow in others, is covered with meadows, through which the river winds, and in several parts, the grass rises up the gradual slopes on the sides, because the water of the springs is retained for a long time in the crevices of the *strata*, and the rubbish that covers them, before it reaches the meadows below.

652. So far as this, my road had lain across the hills which I had seen from the pavillion at *Sans-pareil;* their state within was externally indicated by

the numerous rocks projecting from their rapid slopes, and by the great abundance of large *blocks*, and of smaller masses, every where scattered over the surface. I again passed from the *lime-stone* hills to those of *sand-stone*, without perceiving the transition any otherwise than by the change in the appearance of the soil. These *strata*, then, are certainly not in their original situation; since, wherever that situation is preserved, the *sand-stone* is found to cover the *lime-stone*. I remarked another external sign of the difference of these soils, by which, indeed, I was enabled to distinguish them from a distance; namely, that the woods on the *sand-stone strata*, where the soil is sandy, are of *pines*, and those on the *calcareous* pars, of *firs*.

653. I set out from *Wistenstein*, at three quarters after 3, for *Streitberg*, at which place I was to obtain directions to the *caverns*; and I arrived there at 5 o'clock. As I proceeded in this direction, I found the ground rise, and the hills assumed very different forms: here were no longer any rounded summits, but obtuse pyramids, again, of *lime-stone*, studded with rocks, and overspread for the most part either with firs or with low bushes, according to the thickness of the loose soil; their intervals were in tillage, in the parts where the summits were covered with this soil; but where the rocks were naked, the only product of the intervals was a thin turf. The last line of these pyramids rose, with the appearance of battlements, above a precipice which forms one

of the sides of the valley wherein the small river *Wiesent* flows to join the *Rednitz*, both together falling afterwards into the *Mayn* below *Bamberg*. On arriving between two of these pyramids, the view of this very extraordinary valley suddenly opened to me; it has a resemblance to many vallies in the *Alps*, and likewise to that of the *Rhine* between *Coblentz* and *Mentz*; its sides being abrupt, with projecting rocks, on some of which are ancient castles. The upper part of the slopes is beset with rocks, similar to those of *Sans-pareil*; and both the sides are adorned with firs, wherever these trees have found room to grow, either on the rocks, or in their intervals. The most decided partizans of the hypothesis that *vallies* have been *excavated* by *running waters*, even those to whose geological systems this hypothesis is indispensable, as is the case with the whole of the *Huttonian theory*, would find it impossible to persist in their error, if they would attentively observe such *vallies* as this. From the part of its brow on which I arrived, I saw the small river issue from a very narrow defile; the valley, gradually expanding below this point, had meadows on its bottom; and though its sides still preserved the same marks of catastrophes, there were beneath their abrupt rocks some slopes of rubbish, which extended as far as the borders of the meadows, and were in no place attacked by the stream: these slopes were cultivated, and their lower part was covered with orchards. The whole of this *valley* of the *Wiesent*, so far as I observed it, bears the characters, which are common to all vallies, of *fractures* attended with the *subsidence* of large intermediary masses: as I progressively describe it, therefore, I shall take it as a new example of this great fact.

654. At *Streitberg*, which is an *Amt*, or bailiwick, situated at the bottom of this valley, Baron Von Hardenberg had recommended me to M. Voelkel, the Amtmann. As there were indications of approaching rain, I was desirous to proceed, this same evening, to *Muggendorf*, at about a league's distance, that I might be nearer the *caverns* the next morning; and my driver refusing to go on to that place, because his horses were already tired, I had determined to walk thither; but M. Voelkel would by no means allow of this; and having caused his own carriage to be got ready, he was so good as to take me to *Muggendorf* himself, with the particular view, as he told me, of recommending me to the Inspector of the *Caverns*.

655. The appearance of the sides of this part of the *valley* greatly contributes to explain in what manner vacancies have been produced here; for very large fragments of the broken *strata* having fallen one over another, must naturally have left between them vast interstices in every direction. These *caverns* were discovered accidentally; for their entrances, being very narrow, had been obstructed by other masses, over which slopes of rubbish had been

formed, and the whole had been covered with bushes. But, in the course of time, this soil of rubbish being deeply penetrated with water after a long continuance of heavy rains, it slipped downwards on some of the declivities, leaving uncovered the rocks against which it had rested; and in consequence of this accident, the men employed in cutting wood on these slopes discovered ten successive *caverns*, seven on the right bank of the *Wiesent*, (the side belonging to *Bayreuth,)* and three on the left bank, (the *Bamberg* side).

656. I had not as yet perceived any *marine body* in the *lime-stone* of the country; that which, on the hills, appears on both sides of the *sand-stone*, is of the same nature as that of *Sans-pareil*, and liable to corrosion by the air, whence it has the appearance of being worm-eaten; thus, seeing it only as I passed along the road, I had not been able to discern in it any *marine bodies*, perhaps because they were so small as to be mistaken, at some distance, for the forms produced by erosion. But, on the sides of the valley of *Muggendorf*, the *strata* are, in some places, of a different nature; and as, where they crumble down, they shew fresh fractures, I here perceived *cornua ammonis* and other *shells*. On my arrival at *Muggendorf*, where I went to lodge at an inn, M. Voelkel sent for the Inspector of the *Caverns*, and particularly recommended me to his attention, having explained to him what were the objects which I wished to observe.

657. I had

657. I had a particular view with respect to my observations here. M. Esper of *Erlang*, in his account of these *caverns*, which I have cited in my *Letters to Professor Blumenbach*, speaks of the *bones* that are found here imbedded in stalactite. These bones have been discovered to be those of the *white bear*, an animal belonging to the northern regions; and I had seen a great quantity of them, all of the same kind, in the mineralogical cabinet belonging to the arsenal at *Berlin*. Now in M. Esper's description, there was one circumstance which had particularly struck me; namely, that, in certain deep hollows in these caverns, *sea-sand* was found under the *stalactites*. This had reminded me of a fact which had been related to me respecting the northern coast of *Scotland*; that, on some parts of it, there are *caverns* in the rocks bordering the strand, into which the quadrupeds coming from the sea very often retire, for the purpose either of devouring their prey, or of bringing forth their young, and likewise when they are sick and dying; so that these *caverns* become at last their cemeteries. Hence I had conjectured, with regard to the *caverns* near *Muggendorf*, that while the *sea* still occupied its ancient bed, and its level was progressively *sinking*, in consequence of the *infiltration* of its liquid into the interior part of the globe, (the cause of which has been explained in my elementary works, where I have pointed out several important effects resulting from this infiltration,) there was a certain period, when, the level of these *caverns* having corresponded

with that of the sea, they had served as a retreat to the *white bears* during sickness or old age. There were many circumstances which might tend either to contradict or to verify this conjecture; and hence chiefly I had been induced to come to examine every particular on the spot, where, as will be seen, I met with a very precise fact in confirmation of my idea.

Sept. 15*th.* I had requested the Inspector of the *caverns* to call on me very early, that we might have time for our projected excursion; but the prospect of rain inducing me to wish to shorten it, if this could be done without missing the sight of any essential object, I requested him to give me more exact information with respect to the particulars observed in each of the *caverns.* He then told me, that, of the ten which had been discovered in this district, only two contained any *bones;* that these were the two *highest*, and were both on the left side of the river; but that in all of them there were *stalactites,* under which, in some parts, *sea-sand* was found.

658. This is the circumstance which confirms my conjecture, while it also indicates what was the latest *level* of the *sea* on its ancient bed, before it suddenly retired into the bed now occupied by it; this level corresponding with that of the highest of these *caverns*, they thus afforded to the *white bears* a convenient retreat: the lower *caverns* likewise existed at that time, having been formed by the same ca-

tastrophes of the *strata;* but being below the level of the water, these animals, if sick, could not retire into them for air; and when the *sea* suddenly sank from this point to its present level, the *caverns* were left in the centre of the new continent, and the *white bears,* who find their prey on the sea-coast, and even travel in quest of it over the masses of ice floating on the sea, followed its retreat towards the north. Having obtained this important information, and perceiving, from the appearance of the spot, what must have been the nature of the catastrophes whence these *caverns* had resulted, I determined, as the weather was so unfavourable, to visit only one of each kind; and I went first to one of those which contained the bones, or rather, which had contained them; for such quantities have been carried away, that it is difficult now to find even a few remaining fragments; this was the nearest of the caverns, which is called *Gillingreuth-höhle,* from *Gilling,* a neighbouring village, *reuth,* a land cleared for cultivation, and *höhle,* a *cavern:* it is on the left bank of the river, and *Muggendorf,* is on the right.

659. I set out on foot with the Inspector, at 5 in the morning, though the rain had already begun; he took with him a man who carried a ladder and some lights. We first ascended the *Wiesent* about half a league on the *Muggendorf* side, and then crossed it at the mills of *Bamfort.* We found the valley very narrow along part of this road; yet the river never approaches the foot of the rocks on either

side, but occupies the middle of the interval, where it is bordered with meadows. After this, the upper parts of both sides retreat; but there is below them a kind of terrace, extending nearly to the river, and formed by masses which have sunk to a certain depth. These sides have everywhere the appearance of ruins; and they again advance towards each other at the point where the mills are placed. We here crossed over to the left bank, and came, a little above, to the opening of a *combe*, up which lay our way to the *cavern*, where we arrived after an ascent of about half an hour.

660. The entrance of this cavern, at first narrow, is under a large rock; but the passage soon opens into a wide space, divided into several cells, apparently produced in part by the decomposition of the *lime-stone*, which is here mixed with a great deal of *sand*, and is liable to the action of the exterior air; beyond this, everything is incrusted with stalactites, below, above, and on the sides. Here it may easily be judged that these caverns have originated in the cause to which I have ascribed all cavities of this kind; namely, a more considerable subsidence of the inferior strata than of the superior; for, in the interval thus produced between them, some large masses detached from the latter are found in a nearly vertical position. A crevice opening at the foot of one of these masses, we descended, by a ladder about 20 feet long, into one of the lower *caves*, being that where the bones had been accumulated in the

greatest abundance. This crevice had formerly been almost wholly obstructed by stalactites, which it had been necessary to cut away in order to widen the passage; and it is evident, from certain signs, that there are some fissures of this kind which have been completely closed up in the same manner. The Inspector informed me, that, when this *cave* was first entered, the *bones* were not all covered with *stalactites*; so that it had been possible, without much difficulty, to obtain a great quantity of them very well preserved, among which were entire heads, and many other *bones* characteristic of the species of animal: but that the increase of the *stalactites* since that time had now rendered it very difficult to take out any bones without breaking them. It is beyond a doubt that these bones belong to the white bear of the north, though they differ in some respects from those of the same animal now living; and similar differences are found in almost every species of quadruped, when the *fossil* specimens are compared with the living; as has been shewn, with much detail, by M. Cuvier. The case is the same with respect to marine organized bodies; but notwithstanding this, the corresponding species may easily be known.

661. Another *cave* has been discovered here at a still lower level, by widening an aperture which the *stalactites* had nearly closed. To reach this cave, we were obliged to creep backwards, about 20 feet, beneath a large mass of strata. This brought us into another space covered with *stalactites*; and it was

here that the search for *bones* was at present carried on: I saw fragments of them on the surface, and the Inspector offered to have some taken up for me, which might easily have been done, as the *stalactites* were not yet become very hard; but it would have detained me too long, since I had already seen as much as I desired, and I had still a great journey to make, considering the lateness of the season. It is in spaces of this kind that the *stalactites*, when dug through, are found, in many places, to have been formed on *sea-sand*. Having heard that these caverns contained also other kinds of *bones*, I inquired of the Inspector whether any were found here. He told me that, in the highest of the caves, there were some, though very few, belonging to *carnivorous animals;* a circumstance by no means inconsistent with my idea; for these animals might have entered the cavern subsequently to the great revolution which gave birth to our present continents; while the *bears* followed the *sea*, as it suddenly retreated towards the north, in consequence of its subsidence to its present level.

661, *a*. The *bones*, which are thus discovered in *caverns*, must not be confounded with those *imbedded* in *strata* in various parts of the continents, as well as in their large islands, such as *Great Britain*. The *animals* to which the latter belonged, like the *vegetables* whereof our *coal-beds* have been formed, were originally on *islands* in the *ancient sea*, which, having sunk during some of the earlier catastrophes were covered with new strata by its waters; for the *terrestrial organic bodies* contained in *strata* are found to be mingled with others of *marine* origin. These operations took place at a period preceding that at which, by the gradual infiltration of the sea into the interior part of the globe, the *caverns* just described were left above its level. Now during this earlier period, the changes undergone, as well by the liquid of the *sea*, as by the *atmosphere*, produced very great corresponding effects on organized beings, both *marine* and *terrestrial;* many species became extinct, others experienced various changes, and others could no longer live in our northern climates, where, from the cause explained in my Vth. Letter to Prof. Blumenbach, §. 12, the temperature was very much altered. Such are the reasons of the great differences which M. Cuvier has discovered, in comparing the *fossil bones* found in the *strata* with those of the quadrupeds that now exist; differences of which an account may be seen in Mr. Parkinson's valuable work, entitled *Organic Remains of a former World.* In this work, Mr. Parkinson describes great numbers of *marine bodies,* which have been found in different *strata,* and many *terrestrial vegetables,* which are contained in those covering beds of *coal,* and have no analogues among the existing species; while, at the same time, the *strata* beneath the *coal-beds* contain the remains of *marine animals.* The latter, as well as the *terrestrial animals,* continued to suffer changes, till the epoch of that revolution on the globe which gave birth to our continents;

nents; and in my *Lettres sur l'Histoire de la Terre et de l'Homme*, I gave a particular instance of this in a *sea-shell* found in the cliffs at *Harwich* on the coast of *Essex*. In these cliffs, there is a *stratum* containing a vast abundance of *marine shells*, and among the rest, one which, in that work, I called a *buccinum*, as it has been termed by some conchologists; but LINNEUS has placed it among the *murices*, giving it the name of *murex contrarius*, because its volutions are in a contrary direction to those of all the other shells of the same genus, and even of a *murex*, now living in the neighbouring sea, which perfectly resembles in form this fossil species, the above circumstance only excepted. Now this remarkable shell, which is very well preserved among the others contained in the same stratum, is no longer known to exist in any sea.

661, *b*. This is one of the proofs which I have given in my former works of the *changes* that continued to take place in the *organized beings* on our globe, till the very moment of the birth of our continents; now as it was towards the latter end of the period of these changes that the *caverns*, which I have here described, afforded a retreat to the *white bears*, whose *bones* are now accumulated in them in such abundance, these *bones*, as I have said above, differ, in some respects, from those of the living species; while the *bones* of the *carnivorous animals*, who did not enter these subterranean abodes, until after the great revolution that reduced our globe to the state in which it has ever since remained, have been found by M. Cuvier to agree with those of animals still existing in warmer climates; and it is therefore probable that it may have been the *change of temperature* which induced the latter quadrupeds to descend from the higher grounds inhabited by them antecedently to this epoch, and seek shelter, from the cold of the first succeeding winters, in these *caverns*, wherein they afterwards perished. It is, however, manifest, from the rapid progress of the *stalactites*, that the *bones* here covered with them could not have been accumulated at a period so remote as that at which other *fossil bones* were imbedded in *strata;* for all the *strata* having certainly been formed beneath the waters of the sea, a great length of time must have been required for their production subsequently to the *submersion* of the *islands* which those *terrestrial animals* inhabited while alive.—But it is now time to return to my journey.

662. The rain had ceased, when we came out of the *cavern*, and the clouds being dissipated, the sun illuminated the basin of which this spot commands a view: its circumference has a most dreary appearance, for the sides rise precipitously, and the firs can scarcely find any space to grow on them amidst the projecting rocks: the river winds through the rich meadows covering its bottom, and is seen to turn two wheels, one of which raises the water, by buckets, into a canal that leads it to a village, and the other works a mill. Before I quitted this spot, the Inspec-

tor shewed me the situation of the other *cavern* in which *bones* had been found; it is at some distance from the former, but on the same side of the river, and at the same height; it is called *Mockas-höhle:* there is also a third on this side, which is named *Leitzdorf-höhle;* but it is at a lower level, and contains no *bones.*

663. Having returned to the *Muggendorf* side of the river, I observed on its bed a phenomenon which I had not stopped to examine before, on account of the rain; but it had attracted my attention the preceding evening, in my way from *Streitberg:* this is a soil of *tofus,* sufficiently thick and hard to serve for building stone: it has been cut away on the bed of some of the brooks, but it extends over the whole of that of the river. This is, in the first place, an evident proof that these streams are not employed in deepening their beds; but besides, it is one of the facts which I have adduced against the supposed peremptory argument in the Huttonian theory, in favour of one of its distinctive hypotheses, that our *strata* have been *indurated* by an internal *heat;* this argument consists in the assertion that no materials falling *disunited* to the bottom of the water, can be *consolidated* there any otherwise than by a great *heat.* Here, in the waters of the brooks which flow down these calcareous slopes, and diffuse themselves in the river, *calcareous* particles are held in dissolution by certain other ingredients; and the latter being dissipated under the form of an *expansible*

fluid, the *calcareous* particles, which are thus precipitated, are *consolidated* in a *stratum* on the bed of the stream. In the same general manner have been made successively the precipitations of every separate kind of substance observable in our *strata*; and whether these have been *calcareous*, *quartzeous*, *argillaceous*, or compound, their formation into *soft* or *stony strata* has been determined by particular circumstances.

664. The seven *caverns* on the right bank are all at a *lower* level than that which I first visited, and consequently they contain no *bones*: they lie in various parts of the skirts of the hills between *Streitberg* and *Muggendorf*. The nearest of these, called *Rosenmullers-höhle*, was that which the Inspector advised me to go to see; for had it been the most distant, it would well have merited the preference, on account of the peculiar beauty of its *stalactites*. We ascended to it by a deep cleft leading to a point at which some large projecting rocks rise above their slopes of rubbish. We followed a rapid path up to the foot of one of these rocks, and descended behind it to another, which was surrounded with a rail; a very necessary precaution, its summit being narrow, and its sides precipitous. Here, a small opening having appeared between two masses of rock which leaned against each other, it had been widened, in order to see what lay beyond it; but when the beauty of the cavern within had been discovered, it was thought to deserve every precaution which could be taken to secure it against the attacks

of indiscreet visitors. This entrance was therefore closed by a door with a lock, and the Inspector only is trusted with a key.

665. Immediately within this entrance, we descended a ladder with 36 steps, which is fixed in a large fissure in the rock. A man had gone down before us to illuminate the cavern; and when I reached the bottom of the ladder, I was greatly struck with the scene which suddenly presented itself, and of which I cannot give a more correct general idea, than by comparing it to the inside of a gothic cathedral in ruins. It was illuminated chiefly by a high pole, on which were fixed many hoops one above another, each bearing lights, and which was placed in an open space between the *stalactites;* but besides this, great numbers of candles were placed on small *stalactitical* columns, which, from their situation, looked like the high candlesticks on altars.

666. This resemblance to a gothic cathedral is produced, in the first place, by the salient angles of those pieces of the *strata*, which, happening to have been divided, stopped each other in their fall, and consequently did not entirely follow the subsidence of the lower part; and the whole bottom of the *cavern* was covered with large fragments of different forms, detached by the collision of these masses. Such was the ground on which the *stalactites* were formed, not only on the floor of the cavern, but in all the sinuosities of the sides, and against every part of

the roof. I have seen an engraving of this cavern, which may serve to recall it to the recollection of those who have visited it; but, as will soon appear, no true idea of it can possibly be given by any drawing; to convey such an idea by a simple description is equally impossible; but I will at least explain the principal causes of these astonishing phenomena.

667. In the wider spaces of the vault, the water, trickling over the projecting parts of the pieces thus resting against each other, and dropping from their edges, has covered them with stalactites, which have been so much prolonged as to form draperies, following the outlines of each piece. The water, falling only in drops at equal distances, produces first a fringe of *stalactites*, continuing to increase in length, while its interstices are gradually filled up above: from this operation result the draperies, which acquire the greatest length in the parts where most water arrives, and thus appear as if regularly festooned, and fastened up by strings in the intervals. The drops which form the fringes are not, in general, large enough to fall, but, as their water evaporates, a *tube* is produced by the adhesion of the calcareous matter wherewith it had been impregnated. Drops however fall in some places, where the water arrives in greater abundance; and there, besides the *stalactite* which descends from the point whence these drops distil, an ascending one is formed immediately below it: in many parts, these two stalactites have met, and appear to support the arches of the vault;

which increases the resemblance to a gothic church. Those who have seen chapels belonging to orders of knighthood, adorned with the banners of the knights, may figure to themselves one of the beauties of the roof of this cavern; where, from some parts of the vault, depend undulated stalactites which are throughout of the same thickness, but, their formation having begun from an edge with many flexures, their lower part hangs in large folds: these also are bordered with fringes, and several of them, at their inferior angles, have a kind of tufts, formed by several drops which have met at these points, after trickling down the edges. Lastly, some stalactites, having been at first prolonged in many united tubes, have separated at the bottom, and the drops accumulating and evaporating all around them, various kinds of associations, have thus been produced, some of which resemble church lamps suspended from the roof, and others are like the work bags of some ladies who carry such appendages only for form's sake, the emptiness of the bags being shewn by their deep folds.

668. But the circumstance which chiefly contributes to the beauty of all these various objects is that the *stalactites* are here *semi-transparent.* In the sides of the cavern are recesses adorned in the most elegant manner with fringed curtains hanging from above, which are intersected so regularly as to have the appearance of being festooned with cords; and by the drops distilling from them is formed on

the lower part of these openings a kind of tissue, fringed also, and resembling the usual decorations of seats of honour at public places. The Inspector carried a candle at the end of a pole, by which, when it was introduced into one of these niches, the semitransparent curtain, with its various folds, was shewn to great advantage; the whole of the interior part of the niche being adorned with small columns which terminate above in arches, as in the chapels of cathedrals. When the curtains are thus viewed with the light behind them, it plainly appears that the *fringes* are the rudiments of the *draperies;* they are at first disposed like the quills in a bird's wing, close to each other, and nearly of the same length, each having a drop of water at its extremity; but a lamina of water flows over their surface, and the calcareous matter left by its evaporation serves, as I may say, to solder together the upper part of these small tubes, which continue to increase in length below, while, at the same time the stalactitical lamina becomes thicker. I have mentioned that the bottom of the cavern is covered with large fragments of rock heaped on each other, in some places to such a height, that, by ascending on them, it is very nearly possible to reach the roof; but all these masses are incrusted with stalactites, and their original forms are concealed under others which are very picturesque. There are some projections in the roof whence the water drops on others at the bottom immediately under them; and on several of the latter the stalactites have formed a kind of fringed cushions, which are really very extraordinary.

These stalactites have likewise the property of being *sonorous* when either their laminæ or their tubes are struck: the Inspector went up to a spot which was surrounded with them; he knew the *tones* of the different parts, and striking them with sticks, like a staccato, he produced a kind of music, which, in that cavity, where the sounds were reverberated, had a very singular effect.

670. I have not found it possible to give more than a very imperfect idea of the singular beauty of this *cavern;* but my principal aim has been to describe the progress of the operations which are here visibly carried on; because this progress affords a more exact determination of the *chronometer* furnished by the different kinds of *stalactites.* Here we see, as it were, a *weaver* at his loom, where he is still continuing to weave the *hangings* with which so many parts of this cavern are already decorated: he could not have begun his task until after the *retreat* of the sea from his work-shop; neither can he have been thus employed during any very great number of ages, since he has not yet been able to extend his web over the whole of the cavity in which he is at work.

671. Having returned from hence to *Muggendorf*, where I found my carriage, I set out from that

place at a quarter past 11; and as I wished to reach *Bayreuth* in the evening, I took the shortest road, which is by *Weischenfelh* and *Truppach.* Part of this road is very pleasant, as it abounds in picturesque beauties; at the same time it is capable of affording much instruction to those who may wish to form some acquaintance with the monuments which enable us to carry back to remote periods our researches into the physical events that have happened on our globe: for this tract exhibits a great variety of these monuments of different classes; and since it is only by the repetition of details, in many various places, that general phenomena can with any certainty be determined, I shall not omit the description of those which I observed along this road.

672. The *Wiesent*, in its way to *Muggendorf*, makes a great bend in its course round a mountain, over which I passed, ascending it by the cleft whence I had just returned; the path leading to *Rosenmullers-höhle* being on the left of the road. Proceeding now along the side of the cleft, I saw at its bottom a line of bare gravel, shewing the track of the rain water when very abundant; no water was as yet collected here, though there had been rain this morning and the preceding days. The borders of this track, as well as the slopes on the sides, were covered with grass, which had spread even over the scattered blocks; thus this cleft could not be supposed to have been the work of the waters, even if the *cavern* within had not shewn that

the *catastrophes* of the *strata* might furnish a full explanation of the exterior forms of the mountain.

673. This cleft, towards the higher extremity, is divided into three branches, in each of which the distance between the sides is so small, that the *slopes* of their *rubbish* meet at the bottom. Here I saw an operation going on, whereof the effects are more considerable in the large chains of mountains particularly described in my first Travels; but as these effects are here of the same nature, as they are general in all similar situations, and as they are among those which are most commonly seen in simple hills, I shall repeat the description of them in this place. During abundant rains or thaws of snow, the streams formed in the three branches of the cleft, which unite at this point, attack the *slopes of rubbish*, and carry down the gravel along their course; hence it is that, as I have said above, their track may be followed in dry seasons. The base of these *slopes* being sapped in this manner, they cannot be fixed by vegetation, because their whole surface slides downward, whenever it is penetrated with water. Yet it is evident what must at last be the termination of these effects, which indeed, in many places, are already terminated: they can only continue until the higher rocks, whence all this rubbish falls, shall have retreated so far back, in consequence of their continual degradation, as that the *slopes*, no longer meeting at bottom, shall leave between them an open space of a certain breadth;

then,

then, when a torrent shall be formed, it will have room to pass without attacking the slopes, and they will soon be overspread with vegetation.

674. On arriving at the top of this promontory around which the *Wiesent* bends, the nature of the catastrophes that have here taken place may easily be seen. The whole of this branch of the hill *subsided* in great disorder, at the epoch of the greater subsidence which produced the winding *valley* of the river. The middle part of the promontory, exhibiting a mere chaos of disunited masses, is lower than its edges, on which rise pyramidal rocks, intermingled with firs. I descended from it by a large combe, uniting, in the lower part, with two others, whence issue streams that fall into the *Wiesent*. After having crossed these streams, I followed the direction of the *valley*, ascending the course of the river on its left bank.

675. At this point begins the picturesque scenery which I mentioned above, and which is continually changing all the way to *Weischenfeld;* its beauty arising from the openings, contractions, and various windings of the valley, from its sides studded with rocks and adorned with firs, and from the meanders of the river through the meadows covering its bottom. I must here anticipate a circumstance which I observed above *Weischenfeld:* the scenery there is more monotonous, because the valley is widened by the retreat of its sides to a considerable distance.

Now this is exactly the contrary of what would be the case if the *valley* had been excavated by the *river;* for in this wide part, the stream is much less considerable than it becomes lower down between *Streitberg* and *Muggendorf*, where, however, the *valley* is much narrower. Thus every thing indicates that this *valley* is an original channel, produced by the *catastrophes* of the *strata* before the river began to flow, that is to say, before the birth of the continents; which will appear more and more evidently, and in the first place from the following circumstance.

676. No doubt can be entertained respecting the origin of the *strata* of these hills, since they contain *marine bodies*, and must therefore have been formed in a *continuous* manner on the bed of the ancient sea, which must have remained nearly *horizontal* during their accumulation; however at present they are all *broken* and partially *sunken*, their separated parts having undergone *angular movements.* This may be judged from the surface, as it is every where interspersed with rocks rising above the loose soil; but more especially from the state of the sides of the *valley*, which is manifestly the result of the most considerable fractures, attended with the greatest *subsidence*. It is here easy to perceive, from the exterior appearance of the *strata*, that *caverns*, like those which have been discovered at *Muggendorf*, may probably exist within; it is even to caverns of this nature that we must ascribe

several sudden *subsidences* of some parts of the surface, which have taken place in our continents since their birth, especially in countries consisting of *limestone* and *sand-stone;* as I shewed, in my first Travels, by many examples in the countries of *Hanover* and *Pyrmont.*

677. The interior state of the hills is manifested by another phenomenon; namely, that no *springs* appear here: wells have even been sunk in the hope of finding some, for the use of villages, and of houses scattered on the slopes of the hills; but none have been found; for the whole mass of the hills is completely shattered with vertical fissures, through which, as through a sieve, the rain-waters pass directly down to the level of the river or one of its branches, instead of flowing between the *strata,* till some section on the side of a valley affords them an issue; that being the manner in which *springs* are manifested on the slopes. For this reason, all along the *Wiesent* there are *wheels* with *buckets,* for the purpose of supplying the villages with water: these buckets pour the water into a high wooden trough, which leads it into a canal cut along the slope of the hills.

678. In the *valley* itself, and on its sides, there are phenomena still farther characteristic of its production by subsidence. In some of the upper parts of the sides I observed cavities of the same nature as those which are called *Les Voûtes* in the *Petit*

Salève near *Geneve*, where M. de Saussure considered them as *furrows* formed by the *débacle*, or *current* of the sea when retreating from our continents, as it flowed along the side of the mountain; an idea which never could have occurred to him, if he had but attended to the circumstance that these pretended furrows *rise* considerably in the very direction in which the *current* must have *descended*. But this is only a particular effect of the catastrophes of the strata observable in the upper part of the sides of many *vallies*, and evidently resulting, in this of the *Wiesent*, from the same cause, which, as I have already explained, has produced the *caverns* within; namely, *fissures*, not passing directly through all the *strata*; whence it has happened, that, during the general *subsidence* of the mass, some of the *upper* parts, being supported laterally, have not entirely followed the *lower* in their *descent*, and the vacancies now constituting *caverns* have been left between them. It is where this has taken place on the sides of *vallies* or of plains that the phenomenon now under our consideration has been produced; for when, during the *subsidences* by which these *vallies* and *plains* have been formed in the front of large *fractures*, a solid mass of *strata* has happened to lie immediately above another that has been divided by a *vertical fissure*, one of the separated pieces of the latter having totally *subsided*, has, in some places, left the upper mass projecting like the *roof* of a shed, in a line either *horizontal* or *inclined*, according to the position which the catastrophe has occasioned it to assume. The direction of *Les Voûtes* in the *Petit Salève* is very much inclined; but this is less the case in these cavities on the sides of the *valley* of the *Wiesent*. To the above phenomena is very frequently added another, affording an additional proof of the nature of this catastrophe: I mean *masses of strata* which have fallen forwards, but which having been retained at a certain height by obstacles below, have remained, nearly in a *vertical* position, along the *abrupt side*. I had seen this on the *Petit Salève*, and I again observed it in the *valley* which I am now describing.

679. I have said that the whole bottom of this valley is covered with meadows, it having been levelled with the first materials which the rain-waters brought down from the hills; but the river has not now for a long time deposited here any-thing more than sand. Some vestiges of the original unevenness of this bottom are still to be found in the small ponds and marshy spaces which here and there occur in it, and which, in all the vallies where they are seen, afford the same immediate proof as *lakes* that these *vallies* have not been excavated by the waters that flow in them; for waters cannot form any *hollows* on their bed, but on the contrary, are continually bringing down materials to fill them up; and hence these same phenomena likewise concur in proving the small antiquity of our continents; for, in the course of a very great

number of ages, all cavities of this nature must necessarily have been filled up. My readers must have patience with these repetitions; for it is only by multiplied examples of chronometers of every kind, under different circumstances, that this whole class of phenomena can be demonstrated to depend, not on *local circumstances*, but on the *cause* which has been assigned, and is common to all the cases.

680. After many windings in this valley, where one cheerful landscape was continually succeeding another, I came to a point which at first appeared a *cul-de-sac*, the last of these landscapes being closed by an object in itself extremely picturesque, this was a large rock, advancing from the left bank, and crowned with an ancient castle, which, as I was told, is called *Rameck*, and belongs to Count VON SCHONEBERG. The road turns round this rock, and beyond it, the valley assumes a very different appearance: the upper part of its sides is still beset with rocks, and there are also many on the slopes; but the slopes themselves are more gradual, and are everywhere grassy: the rocks, indeed, are still crumbling down, but their rubbish lies on the slopes, and is soon overspread with grass. As I proceeded, I saw a slope at some distance to the left, a part of which appeared as if covered with *mushrooms* of an extraordinary size; and knowing, that this must necessarily be a deception, I quitted my chaise, and walked up to the spot, where I was much surprized at discovering the real nature of these mushrooms.

There had been here too different *strata* adhering one to the other, which had been broken in a singular manner, leaving great numbers of small rocks, nearly at equal distances, rising above the inferior strata, which were covered with sand. Each of these small rocks was composed of both the kinds of superior *strata;* the action of the air had worn away their angles, producing however much the greatest effect on the lowermost *stratum,* which had thus acquired the appearance of a stalk to the other; this stalk was *whitish,* as it was still probably suffering decomposition; but the uppermost mass, after being rounded, had been overspread with a blackish moss, which secured it from farther erosion; and thus each of these little rocks had the form of a *mushroom,* a foot or two, or even more, in diameter.

681. The valley, after several other inflexions, is at last terminated by two large clefts; and here the cheerful beauties which had hitherto adorned it gave place to scenery of the wildest kind. These clefts being simple fractures through the whole mass of the hills, the height of the hills is consequently that of their sides, which, as I passed along, I saw to be studded with rocks and covered with firs as far as my eye could reach. The *Wiesent* enters the valley through one of these clefts, and is joined by a brook which issues from the other.

682. Here I quitted this river, and crossed a hill, which led me to another valley of a very different appearance; for the hills that border it have no rocks except on their summits, and on both sides they descend in a gentle slope to its bottom, which is very wide and covered with meadows, wherein winds a river called, as I was told, the *Bruckback.* This river is composed of the united waters of the various branches of the valley, which likewise have meadows on their bottom. Here begins a causeway; and I was surprized to see it covered with fragments of *lime-stone*, though, on the heights, the trees between the rocks were pines, which in this country, as I have said, indicate *strata* of *sand-stone;* and in fact I saw those strata in some deep clefts. On inquiry, I found that this *lime-stone* had been brought from a neighbouring eminence; a farther example of the subversion of the whole mass of these hills, by which *strata*, originally situated one on another, have been brought to the same level.

683. I arrived at *Truppach* at three quarters after two; and when the horses were rested, I resumed my journey towards *Bayreuth.* A large tract of meadows winds between hills from the former of these towns to the basin wherein the latter is situated; but, instead of following this tract, I crossed the ridge of hills composed of strata of *sand-stone*, over which I had passed in a contrary direction in my way to *Sanspareil;* and proceeding along the same road whence I had turned off to go

to that place, which now lay on my left, I arrived at *Bayreuth* at three quarters after five.

684. I was glad to have it in my power, this same evening, to pay my respects to Baron Von Hardenberg, from whom, and from M. VON AINITZ, nephew to the Miniſter at *Berlin*, I obtained all the directions and recommendations for which I might have occasion in the remainder of my journey. The Baron had even the kindness to give me a small topographical map drawn by M. HUMBOLDT, who was then engaged in the great voyage which has afforded the world so much information respecting the southern parts of *America*; this map proved extremely useful to me. It was settled that I should send on my chaise, by the usual road, to *Alexanders-bade*, a bathing place situated in that part of *Fichtelberg* which borders on *Bohemia*; and that I should hire a horse for my excursion in the mountains, with a guide, to shew me the road, and take care of my horse in those parts where I might be obliged to walk, until I should obtain the assistance of some persons well acquainted with these mountains, to whom M. TORNESI, Director of the Office of Revenue, had written the day before, requesting them to direct me.

Sept. 16*th*. I had intended to set out very early this morning; but it had rained the whole night, and was still raining. However, as it held up about 10 o'clock, I determined to begin my journey, though there was little appearance that the weather would be fine.

685. When from the hills between *Hof* and *Berneck* I had viewed on my left the chain of the *Fichtelberg*, it had appeared as if the cultivated grounds rose up to the fir-woods which covered the summits of those mountains; but this was an illusion, as I more evidently saw, now that I was going directly towards to the latter, the former being separated from them by several longitudinal vallies. On setting out at present from *Bayreuth*, the valley of *Berneck* remained on my left, and the first part of my road lay over *strata* of *sand-stone*, with *pines* on the summit of the hills. I then came to a cultivated soil, consisting of rubbish of *lime-stone*, the strata of which, wherever they could be seen, inclined inwards, presenting their sections at the surface; in these, among other shells, I saw some *cornua ammonis*. The same *strata*, with various inflexions, prevailed as far as the highest part of this ridge of hills, where it is abruptly cut down towards a valley, on the rapid slope of which I saw some rocks of *sand-stone* in great disorder. This is a confirmation of the cause that I have already assigned to the alternations of these two classes of *strata* at the same level: the *lime-stone* was originally covered by the *sand stone;* but, during the *subsidences* which produced this valley and that of *Berneck*, the *angular motions* of the masses of the former, in those parts where they now are found at the highest level,

caused the *strata* of the *sand-stone* to slide downwards on both their sides. A new effect of these motions will appear in the sequel.

686. My road lay through *Weydenberg*, a place situated in this valley, which separates the hills from the chain of the *Fichtelberg*, and affords a passage to the *Rothe Mayn*, or *Red Mayn;* so called, because, when it overflows, it attacks the foot of some hills, the loose soil of which, being mixed with red clay, imparts that colour to its water. This river, proceeding from the high grounds of the *Fichtelberg*, and here, inconsiderable in size, has formed in this valley, where the bottom and the slopes on the sides consist entirely of stony rubbish, the chronometer common to all similar situations; for having cleared its bed through this rubbish along the foot of a hill on which *Weydenberg* stands, and finding an open space on its right bank, it has spread over the latter a great quantity of these materials, having reduced into a *cliff* the side of the hill of which it has attacked the foot. I ascended the course of the river as far as the beginning of the *cliff*, in order to observe the *progress* of the operation. From this spot, prolonging with my eye the rapid slope of the hill to the point where this imaginary line met the horizontal ground on the opposite bank, I saw exactly how much of this slope must have been washed away, to form the *cliff;* but the river, having thus straitened its course, has for some time ceased to beat against the point first attacked, which

was the lowest, and which, being softened into a slope, I now saw covered with grass. The rest of the cliff was approaching to the same state in its lower parts; but in the higher, more time must be required to produce a similar effect; because the materials detached from them are carried away by the river when it overflows. Here, therefore, the *cliff* must retire, in consequence of its continual abrasion, that its own largest materials may form at its foot a *beach*, which may keep the river at a distance from it. I observed the beginning of this *beach*, consisting of the rubbish of the *stony strata* of the hill intermixed with that of the *soft;* the sections of both appear in the cliff, and shew the catastrophes which they have all undergone: on looking towards the *cliff*, I saw these *strata* descend from left to right; and they also incline inwards.

687. This *beach* is already of sufficient height to be walked on when the river is not too full; I followed it down the course of the stream, till I came to a deep cleft wherein flows a brook arriving to join the *Mayn*, above the part of the *cliff* behind which lies the slope whereon *Weydenberg* is situated. On entering this cleft, I found that its sides, originally abrupt, were now reduced into regular slopes and covered with grass; so that they no longer suffered any demolition. The *Mayn*, being met at right angles by the stream flowing in the cleft, has been so far repelled by it as to pass now at some distance from the foot of the remaining part of the exterior

cliff, which is consequently softened into a slope, and overspread with grass; and as the church stands at the top of the hill, a flight of stone steps has been made to it up the slope; it is difficult to ascend these steps, for they are very narrow. Higher up, the water of the river is received in a canal, and led to supply some mills near the opening of the cleft; and between the canal and the foot of the slope there is a road, along which I saw entrances to some cellars hollowed out by the inhabitants in the mass of the hill.

688. On viewing here this branch of the *Mayn* below its issue from the vallies of the great mountains, it cannot possibly be supposed to have brought with it any stones from thence; for all the stones which are found on this part of its bed are of the same nature with those that form, as well the slopes descending towards the valley, as the soil of the valley itself; the river, in clearing its course, has spread these stones, in some places, over the bottom of the valley, in others, along its slopes; and now, its bed being nearly fixed, it carries with it nothing, during its inundations, in addition to the sand, except the minute gravel which, at such times, it still detaches from some parts of the foot of the hills.

689. Returning to *Weydenberg* at about two o'clock, I found there M. KILLINGUER, Inspector of the Mines, who, in consequence of a letter from

M. Tornesi, had been so good as to come thus far to meet me, in order to conduct me himself to *Goldcronach*, the place of his residence, from which we were to set out the next day on our excursion to the interior part of the mountains. The first part of our road was down the course of the *Mayn*, along the side of the hills whence I had descended into this valley; and we came to a space where the bed of the river was covered with *blocks* of *quartz* and of *grey wacke*, between which it foamed: it had certainly not brought these *blocks* down to this spot, for I had seen none in the upper part of its course; neither had they fallen from the sides of the valley, because there the strata are of *lime-stone* or *sandstone;* they could only, therefore, have been thrown out from within, during the *subsidence* which produced the valley; and it may soon be judged that this could not have been the operation of a single *catastrophe.*

690. We crossed the *Mayn* in the part where these blocks lay; for M. Killinguer did not take me to *Goldcronach* by the direct road, because he wished to shew me a singular phenomenon. We followed for some time the left bank of the river, and then, crossing back to its right bank, we ascended the side of the valley opposite to that on which I had at first descended into it. Here nothing but rubbish appeared on the surface of the slope; but it having been judged from some external indications that *gypsum* lay beneath, the rub-

bish had been dug through, and *strata* of *gypsum* being discovered, they had been worked for some time, after clearing it away. But the farther these *strata* were followed towards the hill, the more did the rubbish increase in thickness; and the expense of removing it becoming at last too great, the expedient had been adopted of working them in the manner of mines. For this purpose, a shaft had been sunk here, and a canal opened to carry off the the water accumulating below the level of the surface. This mass of *gypseous strata* is of great thickness, and is found to lie on *strata* of *sand-stone.*

691. Hence then may be determined by what succession of catastrophes the *valley* and the *hills* which border it acquired their present state while still on the bottom of the *sea;* for *gravity*, *running waters*, and *atmospherical actions*, the causes acting on the continent since its birth, have not produced on it any other effects than such as I have already ascribed to them. The *strata* of *gypsum* were formed on those of *sand-stone*, after the latter, which had covered the *lime-stone*, had slidden down to a lower level, in consequence of a first *subsidence* and *subversion* of the *strata;* but the whole assemblage of these *strata* being afterwards broken by a new *subsidence*, a part of those of *gypsum* and of *sand-stone* passed below the level of the valley, leaving their *sections* on the slope, where they have been discovered; and the violent shocks which were

occasioned by this last catastrophe covered the whole surface with a vast abundance of the rubbish of the *lime-stone strata*. Not one of the *strata*, down to the very lowest, is now remaining at the level at which it was originally formed; all of them have more or less *subsided*, as I have shewed before on various occasions; and it was during the last great *subsidence*, which formed the *valley*, that the masses of *quartz* and of *grey wacke*, scattered over a certain space on the bed of the river, were expelled by the *expansible fluids* from the interior part of the globe. I ascended the hill, and walked some way on its summit; it is rounded, and cultivated on a soil consisting of the rubbish of the same *lime-stone* which composes the opposite hill, and contains *marine bodies*, especially *cornua ammonis*.

692. Hence we proceeded to *Goldcronach*, where we arrived at three quarters after seven, and M. Killinguer was so good as to lodge me at his house: he informed me, amongst other particulars relative to this place, that some veins of *quartz* containing grains of *gold* had been followed here for a very long period. He told me that, in the part worked at present, these veins were very thin, and scarcely yielded sufficient profit to defray the expense; but that, notwithstanding this, they were still followed, because, from documents carried back 600 years, they were known to have been at one time much thicker and richer, and it was therefore hoped that they might again improve. These veins, or small

loads, are very numerous; they increase and diminish in size, and as they are followed farther in the mountain, they are found to be variously ramified in some parts, and to reunite in others.

Sept. 17*th.* At half past seven in the morning, I set out with M. Killinguer for the *Ochsen-kopf* (or Ox's head,) the second in height of the *granitic* summits of this chain, the most lofty of which, as I have already said, is the *Schnee-berg*, or Snow-mountain. We preferred the former eminence because it was the nearest; for it had rained all night, and was still raining: and the clouds had a very threatening appearance.

693. Our road towards this summit lay over several ridges of *schistose* hills, the first of which, as I was told by M. Killinguer, is crossed by a *vein* of *antimony*, inclining so much as to form an angle of about 60° with the horizon. These *schistose* ridges rise one above another, and we passed over that which contains the *auriferous veins.* In following these hills, I observed the *schisti* change from *argillaceous* to *micaceous*, till at last they were succeeded by *gneiss;* and it is manifest that the ridges must have been produced by the *angular motions* which have taken place in these strata originally formed one upon another, because wherever the *strata* are seen, on the summits, above the loose soil, they present their upper *section*, and its aspect shews that they *incline* considerably inwards. This

loose soil is mixed with abundance of *blocks*, some of which belong to the inferior *strata*, but others have no connexion with them; among the latter are some of a stone called in this country *grün-stein*, and *porphyric grün-stein*, of which I shall have occasion to speak in the sequel. A rivulet, issuing very clear from a high *peat-ground*, crosses the road, and precipitates itself into a deep cleft; I followed it to the point of its fall, and saw it rush down foaming amidst blocks: that it has not propelled them hither is very certain, since it issues from a small *lake of peat*; and at the bottom of the cleft I saw it flowing calmly in meadows: on the slope therefore, where it flows rapidly, its only operation has been to wash away the loose soil from between the *blocks* with which the whole surface of these hills is overspread.

694. As we were passing over these heights, M. Killinguer shewed me the *Ochsen-kopf*, on our left; and it seemed as if we might have gone directly thither, though we still had to cross several vallies, which separate the ridges of *schistus* and *gneiss* from the *granitic* chain. We first descended considerably towards the valley of *Warmen-steinbach*, which is very rich and in tillage, and in which flows the *Red Mayn;* but before we arrived at its level, we entered a large cleft with its sides abrupt, though there is only a rivulet at its bottom: in the lower part of this cleft another opens, whence issues a larger stream; and the two, uniting, flow together

on a bed covered with *blocks* of various species; which is not surprizing, since they are disseminated over all these hills, as well on their summits as on their slopes. We here entered the valley of *Warmen-steinbach*, where these waters, with those of a third stream, fall into this branch of the *Mayn*; a large space, which is in meadows, has been levelled by them, below the point of their junction; but they have not filled up all the cavities in it, for I saw some marshy parts covered with rushes. The *Red Mayn* is here very near the *granitic* chain in which it rises; yet there are no *blocks* of *granite* on its bed, but only the same stones that are found in the neighbouring soils; as is likewise the case on the beds of the other streams which arrive here to join it.

695. Having passed over this horizontal space, we ascended a ridge of hills which borders the *Mayn:* these hills still belong to the schistose ridges, and are very favourable for shewing the state of the *strata*: the sections of the latter are every where open to view on the road; for these strata incline considerably inwards, and are covered with only a very small quantity of loose soil; and as their direction obliquely cuts that of the ridge, their succession appears on this summit, as distinctly as it is elsewhere observed in different ridges: so that, as we walked on, we passed over masses of *strata*, (in German, *lagen,)* successively of different species: the progression of all these species to *gneiss* was

here seen *horizontally;* because, in consequence of their *angular motions*, their relative level has been changed. There are also *blocks* on the surface, which change as well as the *strata;* and this explains the transition in those disseminated over the preceding ridges, and covered with a loose soil, of such thickness, that the *blocks* contained in it can rarely be compared with the *strata*, also *inclined*, which lie beneath. It farther appears, from the thinness of the *loose soil* of the present ridge, comparatively with that of the others preceding it, that this soil has not been produced on the continent since the retreat of the sea; for all these ridges have been exposed to the action of the same exterior causes; this soil, therefore, must have resulted in greater or less abundance from the trituration of the masses of strata which took place during the catastrophes.

696. On reaching the summit of this ridge of hills, we found it cultivated around a hamlet called *Keyersberg*, belonging to the *Upper Palatinate*. In tilling the surface, where the loose soil is so thin, it has been necessary to clear away the *blocks*, which are laid along the sides of the fields; they are of *granite*, while the strata beneath are of *schistus* and *gneiss;* the *Ochsen-kopf* is here in view, but it cannot have been the source of these *blocks;* being separated from this ridge by a vale covered with meadows, through which no water passes but in rainy seasons. In this vale, there are great quanti-

ties of *blocks*, consisting of *quartz* intersected with veins of *black iron ore;* these masses must undoubtedly have belonged to a *load*, but M. Killinguer told me that none such is externally known; it probably sunk under the soil of the *vale*, during the *subsidence* which produced this cavity, and of which one of the effects was the expulsion of its fragments from within by the compressed *expansible fluid*. There is here another village called *Keyersberg*, belonging to the country of *Bayreuth*.

697. Being now at the foot of the *Ochsen-kopf*, we hired two men from the village, one to take care of our horses, and lead them round to the opposite side of the mountain, when we should be obliged to proceed on foot, and the other to be our guide to the summit, which, from this side, was concealed by woods. The whole surface of the mountain, in the part where we ascended it, was covered with *coarse sand*, the product of *decomposed granite*, very similar in appearance to what I have described in *Devonshire* and *Cornwall*, in my Travels already published, under the name of *growan;* but in the latter there are grains of *tin-ore*, which are not found in the *granite* of those counties; nor are there any either in the *sand* or in the *granite* of the *Ochsen-kopf*; on the slope of this mountain, we found the sand covered below with grass, higher up with beech-woods, and towards the summit with firs.

698. When we had arrived above the woods, we found that the rest of the mountain was merely a congeries of large *blocks* of *granite,* buried under a kind of cushion of thick moss, the growth of which is favoured by the moisture of the clouds often covering the summits of the chain, this moisture being here retained by the *granitic sand* scattered among the *blocks:* on this moss were growing in great abundance the *Vaccinium myrtillus,* and the *Vaccinium vitis Idæa,* the berries of both which plants are very refreshing in excursions among mountains; at this height they were at present ripe, and I was glad to eat some; but I paid for them very dearly. There is no ground on which it is more dangerous to walk, than *blocks* so much covered with moss as to be nearly hidden by it, and this was the case here; the moss being so thick, as not only to conceal the *blocks,* but itself to assume their form, and to serve as a soil to other plants. We were now on an ascent, where, as we advanced, we were obliged to sound the ground before us with a stick, in order to be sure of setting our feet on *blocks.* Unluckily, our guide, perceiving that I greatly relished the bilberries on this mountain, brought me a branch on which they were so large and so closely arranged, that it might have been taken for a bunch of grapes; I forgot for a moment on what kind of soil I was walking, and holding this branch in one hand, I was pulling off the berries with the other, when, having set my foot on a high tuft of the moss, which I took for a part of a block, my leg suddenly sunk in a

deep interval; I fell, and my left knee striking against a real *block*, I thought for a moment that I had broken the knee-pan; the pain was so acute, that I had nearly fainted; but when it had a little subsided, and I found that I was able to move my knee, I called the guide, who assisted me to rise, and I walked on, throwing away my bilberries however, and sounding with my stick at every step. Finding that the pain was all I had to suffer, and being extremely anxious not to lose this opportunity for very interesting observations, I determined to continue my walk, with the assistance of M. Killinguer and the guide.

699. When we had reached a certain height, I saw, between the eminences, a large horizontal space, which M. Killinguer told me had formerly been a *pool*, and still bore the name of *Fichtel-see*, though now filled up with *peat*. This space is the reservoir of the waters descending from this side of the *Ochsen-kopf*, and from all the other summits around: two streams issue from its opposite extremities, one of which is the *White Mayn*; a name first given to a small stream that flows down into the *Fichtel-see*, from a granitic summit called the *Farnleiten*, and afterwards continued to the river itself, which, taking a northern course after its issue from the peat-ground, arrives at *Berneck*, where I have already described it. The other stream proceeds from the same space in a southerly direction; and assuming immediately the name of *Naab*, it flows in the *Upper Palatinate*.

This is one of the spots of which so many are to be found in these mountains, and which, had they been observed by those who have supposed the *streams* descending from mountains to have excavated the *vallies*, must have effectually prevented the rise of such an opinion. It is through *vallies* between the neighbouring eminences, that the waters, which issue from this space in the form of two *rivers*, first arrive in it; and during all the time that has elapsed since they began to flow, they have not brought hither a sufficient quantity of materials to obliterate this *cavity*, which is filled up with *peat*, and from which they issue in a state of *limpidity*.

700. The slope by which we ascended consisted totally of *blocks*, the *granite* no where appearing in its original situation, but lying in distinct masses, some of them not inferior in size to houses. It cannot be supposed that these masses have been detached from *higher ground*, for this eminence is not commanded by any other. This then is a phenomenon similar to those which I have described in the *Hartz*, in *Silesia*, and in *Saxony*, and from which it is evident that the *strata* of *granite* were originally formed at a more elevated level; and that, during the general *subsidence* of their whole mass, some greater partial *subsidences* produced the *vallies*, and covered many of the summits, which then became such, with these large fragments. I do not hesitate to speak of *granite* as *stratified*, for though there are some mineralogists who do not admit this fact,

their denial of it must necessarily have resulted from very imperfect and partial observations. I have shewn that there are distinct *strata* in all the *granite* of the *Giant's mountains*; and the same will likewise be found in every part of the *Fichtelberg*. Towards the top of the *Ochsen-kopf* there is scarcely any moss, and the *blocks* lie open to view; in many of them I distinguished the *strata*, not only by the *lines* of their *separation*, but by the difference of the *crystals* on the opposite sides of these lines. There were, it is true, some very large *blocks* wherein no *strata* could be perceived; a circumstance which has elsewhere deceived those who deny the *stratification* of this stone; but it has been already remarked by M. de Saussure, that such an opinion could never have occurred except to persons who had happened to observe only some *strata* of very great thickness, without carrying their researches any farther.

701. This congeries of blocks on the *Ochsen-kopf* forms two eminences, on one of which somebody has decorated the mountain with a coat of arms symbolical of its name, a large *ox's head* having been traced with some sharp instrument on the face of a block in a very elevated situation. The kind of tree which grows at the greatest height among these rocks, where, however, it does not attain to any considerable size, is the *mountain-ash*; its red berries, hanging in large bunches, were now ripe, and attracted vast flights of thrushes. It was about half past 12

when we arrived at this spot, where we made a halt, of which my knee stood greatly in need, and during which the weather fortunately cleared up, so that we were able to see the fine prospect commanded by this summit: M. Killinguer took the trouble to point to me the several eminences here lying below us; and he likewise turned my attention to the country over which I had passed between *Hof* and *Berneck*: I had found every part of this tract intersected with large vallies; but hence it appeared only a plain, and I could not distinguish whether the woods with which it was interspersed indicated stony summits, or abrupt slopes. On one side we saw the *Schneeberg*; its summit, formed likewise by a heap of *blocks*, rose a little above us: we were separated from it by a large vale, in which, on our left, was situated a village called *Bischoffs-grün*, whither our horses had been sent to wait for us.

702. We descended from the first of the eminences of *blocks* on the *Ochsen-kopf* in order to ascend the other, which we found to terminate in a precipice on the side next the slope. Being told by the guide that there was something curious to be seen below these rocks, we determined to go to view it; but for this purpose we were obliged to descend the precipice, which I could not do without great difficulty, on account of my knee: on arriving at the bottom, he led us to a deep cavity, like a well, where I saw in the sides only *blocks* piled on each other in a disordered manner; the guide told us

that it was practicable to descend from *block* to *block* to a great depth, and that, at the bottom, under immense stones, there was an opening into a cavern. Hence may be judged what convulsions these *strata* must have undergone throughout their whole mass.

703. From this point, we descended the mountain on the side opposite to that of our ascent, and very different from it; the lower part of that side being covered, as I have said, with grass on granitic sand, up to the woods that occupy the slope composed of blocks imbedded in moss. But the side on which we descended was entirely overspread with *peat* under a thick moss, and the firs growing in the upper part were small and stunted: there were no projecting rocks, and the blocks scattered on the surface were very small. I suspect that, in the catastrophe which reduced to their present level the low spaces around this eminence, the principal *fracture*, and the most immediate *subsidence*, took place on the side next the valley where the *pool* is situated; that the *strata* present their *section* on that side, and their *inclined planes* on the opposite one by which we descended; and that the formation of the *peat* is owing to the water retained by these planes. In the woods, the slope is very rapid; it has less declivity below them, where the *peat* still continues; but there being here less moisture than under the trees, it is covered in this part with good herbage, and forms meadows which extend down to the borders of the *White Mayn*, after its issue from

the peak. This slope, towards its foot, is covered with immense *blocks* of *grey granite*, different from that of the mountain itself, and containing large crystals of feldspar.

704. At half past three we reached the forges at *Bischoffs-grün*, where M. Miller, the director, having had previous notice of our arrival, received us with great civility; and we staid there the remainder of the day. This rest was very necessary for me, for I suffered much pain from my knee. Mad. Miller was so kind as to cause it to be immediately wrapped in cloths dipped in brandy with soap dissolved in it; and this greatly relieved me. I continued the same application throughout my whole journey, which I could not suspend, on account of the lateness of the season; so that I was glad to be thus enabled to proceed, though with difficulty. But I was still very lame at my return to *Berlin;* for an extravasation of lymph had taken place in the tunic of the patella, which it required almost three months to dissipate.

705. This same day, however, after dinner, my knee having had some rest, I went out again to observe the vale. A large promontory, which branches off from the *Ochsen-kopf*, extends horizontally into the vale, and terminates just opposite to the forges; its whole surface is covered with large *blocks* of *granite.* In the vale, I saw likewise abundance of *blocks* of the same *quartz* intersected by veins of *black*

iron ore, which I had seen in the vale on the opposite side of the mountain; and this leads me to believe that the *gneiss*, as well as the *schistus*, originally lay on the *granite* over all this part of the bottom of he ancient sea, and that, during the catastrophes of the *strata*, they both slid down towards the side where the greatest *subsidence* took place, leaving the *granite* uncovered; but that all the *strata* having been broken in the latest catastrophe, among other fragments, those of a *vein* which had been contained in the *gneiss* were thrown out by the *expansible fluids* into the two opposite vallies. Many other phenomena will successively appear, to prove the above to have been the effects of the catastrophes in this region; and I have already shewn that, on the outer side of this chain of mountains, the *strata* of *lime-stone* were in the same manner left uncovered by the sliding down of those of *sand-stone* towards the points of *subsidence.*

706. I must now mention another phenomenon of this vale, to shew that, at the moment of its production, the *strata* were subverted, and that such as were here swallowed up were reduced into fragments, which were afterwards ejected from within. In this vale, as far as to the foot of the *Ochsen-kopf*, are found *blocks* of the stone here called *grün-stein*, which I have already mentioned as being also scattered in the vale on the other side of the mountain; but they are the most valued in the vale of *Bischoffs-grün*, where they form an object of manufacture.

Now

Now M. Miller informed me, that neither of this kind of stone nor of the former was any rock or stratum known to exist throughout the whole country.

707. The *grün-stein* (or green-stone,) is easily melted with potash into a *black glass* which is used for making buttons, and large beads for necklaces; I shall speak only of the manufacture of buttons, where great diligence is requisite, the article being sold at a very low price. Pieces of iron wire are first prepared, which are bent in a circle, with their ends turned back in hooks: the workman takes up one of these pieces by the middle, with a pair of iron pincers, near three feet long, which form the extremity of a small iron bar, on which there is a running ring to fix their hold of the wire: he then dips the hooks of the wire into the crucible of melted glass, of which they take out a certain quantity; and immediately rolling the bar on a proper support with one hand, he forms the button with an instrument held in the other. The workman is paid two kreutzers for 20 dozen of these buttons, and he makes in the day eight times that quantity. These 20 dozen, strung on a thread, are sold at the place of manufacture for eight kreutzers, which amount only to half a French sol. The furnace has 12 mouths, six on each side, so that 12 workmen may be employed at a time; they relieve each other every six hours, because, when the glass is in a proper state, the work must go on day and night, without intermission.

Sept. 14*th.* I could not spare time to remain at *Bischoffs-grün,* though I experienced so much kindness from M. and Mad. Miller, that it would have been of great advantage to my knee to have staid here a little longer; but M. Killinguer was obliged to return to *Goldcronach,* and was to put me into the hands of another guide for the rest of my journey.

708. We set out on horseback at half past six in the morning, and first ascended the grounds on the right bank of the *White Mayn,* in order to reach a pass in the line of mountains descending from the *Schnee-berg.* This pass is a large cleft, which has steep sides covered with firs, and in which are collected the waters here flowing towards the *Mayn;* but at the upper end it opens into a high tract called *Die Höl,* gradually sloping in an opposite direction; and on this side, all the waters flow down to the *Eger,* which takes its course through *Bohemia.* Though this pass is in the *granitic* chain, its soil is entirely covered with rubbish of *gneiss.*

709. From the highest part of this pass, we had a view of a vast circular chain of cones covered with wood, which, from their form, might be supposed volcanic; but M. Killinguer informed me that those beginning this circle on the left are of *granite,* and rise from a common base; most of these have a high *rock* on their summit, and their slopes are covered with *blocks.* It is on account of these rocky

summits, a rock being in German called *stein*, that the names of the mountains of this kind are terminated with that word: thus, on the left of the spot where we stood, there are the *Wald-stein*, and the *[illegible]precht-stein*, on which stand ancient castles. The other eminences in this circle, without any visible rocks on their summits, are called simply *berg*, (mountain;) as the *Korn-berg*, and the *Heid-berg*. These mountains resemble a string of beads, in which the *Schnee-berg* rises above all the rest. There are some other *granitic* cones detached from the chain, and dispersed in various parts of the amphitheatre below; of these, the nearest to us was the *Rollen-stein*.

710. I have said that, on this side of the chain, the waters flow down to join the *Eger;* and in fact the first brook to which we came here bears the name of that river; it rises in a marshy soil, and the stones found in the higher part of its course are fragments of *gneiss*. As soon as we had issued from the woods by which this pass is chiefly occupied, we saw, in the nearest part of the large basin here opening to the view, the *lake* of *Weissenstadt*, with the small town of that name at its extremity. This *lake* is surrounded with *morasses;* for it is the lowest part of a *peat-moor*, which is continually incroaching on it, and of which the borders, not yet consisting of solid peat, are still covered by the water. Another branch of the *Eger*, rising also in a marshy soil, at the foot of the *Rollen-stein*, joins the former before

it

it enters this *lake*, the reservoir of the waters of the whole semicircle on the left, which issue from it in one stream, under the name of the *Eger*. We have here then another chain of mountains deeply intersected, with very rapid slopes; and of these mountains also it is impossible to ascribe the forms to *running waters*, because all the materials which the streams have brought down ever since they have flowed have not yet been sufficient to fill up the original cavity of the *lake:* this cavity will at last be filled up by the *peat*, like those which I have described in the country of *Mecklenburg*, at a very low level on the continent; and in speaking of the *chronometer* afforded by the increase of the *peat* at that level, I then referred to the *lakes* of these mountains, in order to shew that it was the same at every degree of elevation. After having descended a part of the slope towards this basin, we found rubbish of *granite* mixed with that of *gneiss*; and at last the former prevailed alone.

711. When we came to the bottom of the hill, we went first to the forges of *Weissenheid*, from the master of which, M. Waeckler, we had a very obliging reception. There we found M. Sievers, another Inspector of the Mines, who, having been apprized at what time I was expected, had come hither on purpose to meet me, and to accompany me throughout the rest of my excursion; M. Killinguer, as I have already said, being obliged to return from hence to *Goldcronach:* before the departure of the latter,

it was agreed, that, as all the conical eminences following each other on the base of the *Schnee-berg* are of the same nature, it would be sufficient for me to observe the *Rollen-stein,* which was the nearest of them, and from which I might form a precise idea of them all; and accordingly I immediately set out for it accompanied by M. Sievers and M. Waeckler.

712. In our way to this eminence, we first ascended to a tract of ground, which is above the level of the *lake,* and forms a kind of terrace along the foot of the mountains. Those parts of the terrace, where originally there were but few *blocks,* have been cleared of them, the higher for the purpose of cultivation, the lower for that of extending the meadows which cover the bottom of the basin; but at all levels there are some parts where the *blocks* lie in such prodigious abundance, that the acquisition of ground would not compensate the expense of removing them for agricultural purposes; there is, however, another use for which they are taken up; and this I shall now explain. It is here distinctly seen, in the several masses, as well by the difference in their crystals, as by that in their thickness, that they have belonged to different *strata:* I saw some which were 20 or 30 feet long, and very broad, yet not more than two or three feet thick; but some were considerably thicker: in the former, the crystals were very small; in the latter, they were generally larger. The great size of these thinner

flakes, and the smallness of their crystals, renders them very proper to be used as hewn stone; they are accordingly cut into very long pieces for the pilasters of doors; for window-frames, benches, and every other purpose, and even formed into arches, in a single piece, for gate-ways; they are hewn in the following manner. The flake being always flat, as having made part of a *stratum*, the line in which it is intended to be divided, is first deeply traced in it; along this line, holes are made with a chisel, at the distance of two or three inches from each other, and of a proper form and depth to allow steel wedges to stand upright in them; each of these wedges is then driven deeper in its respective hole with a hammer of a moderate size, till it is felt to be firmly fixed there; after this, all the wedges, in succession, are struck very forcibly with a heavy hammer, passing and repassing along the whole line; and the piece being thus detached in the form which had been traced, it is afterwards finished with hammers and chisels of different kinds.

713. On viewing this spot, and every thing around it, no supposition can possibly be entertained that the *blocks* which cover it, and are successively removed for the purpose above described, can have fallen into it from a higher spot, or indeed that they have been transported hither from any quarter whatever. The whole bottom of the large basin was at first covered with similar *blocks*, which, in the lowest parts, are now buried under the rubbish

and sand brought down by the waters from the surrounding heights during seasons of long rains, or the melting of the snows; and the ground thus levelled is now converted into meadows. It may be judged that such is the case, because, throughout this space, and even in the centre of it, there are, above the level of the meadows, certain spots which are covered with *blocks*, and look, as I was told, like *islands*, when the rest is flooded. This then must have been a great focus of explosion for the interior *expansible fluids*, during the formation of the *mountains* by the *subsidence* from which their *vallies*, and particularly this large basin, have resulted.

714. The *Rollen-stein*, whither we were going, rises in a cone from the above *terrace;* its slope is covered with firs, and very rapid; there are on it many rocks; but I shall speak only of those which crown its summit, and are very singular. They form several large angular columns, 40 or 50 feet in height, being masses of nearly *vertical strata:* the *stratification* is distinguishable, not only because the crystals are dissimilar in contiguous *strata*, but because the joints have been deepened by erosion: it is remarkable that, as I was informed by both the gentlemen who accompanied me, these rocks consist of the same *granite* as those which rise on the largest eminences belonging to the chain; as is evidently shewn by this particular circumstance, that these *strata* contain a mineral substance, which, on being decomposed by humidity, imparts to their

surface a reddish tinge. It is therefore probable that, during the subsidence of the mass originally filling the cavity of the basin, there were left on its borders the large fragments now composing these distinct eminences, the summits of which, at their different degrees of elevation, were formed by the same *strata*, remaining in each at the highest level: it was then also that the vast quantities of blocks which cover both the basin and its borders were thrown out and dispersed by the expansible fluids. In this great catastrophe of the *strata*, some of their masses near the summits happened to be split; and the action of the air having enlarged the fissures by decomposing the surface of the *granite*, these masses have been thus reduced into insulated pillars. The *granitic sand*, here covering the slopes of the mountains, is the product of this operation, and of the same action of the air and other causes on the *blocks*, of which, though they still remain in their original place, the angles are *rounded*. I have described the same phenomenon on the *Giant's mountains*.

715. From the top of one of the granitic columns of the *Rollen-stein*, to which I found great difficulty in ascending on account of my knee, I had a view of all the intervals between the mounts on the left, wherein are collected the waters flowing down into the *lake* of *Weissenstadt*, whence issues the *Eger*: those proceeding from the northern side of the mountains here opposite to me form the origin of

the *Saale*, which passes through *Zell*, *Hof*, and *Gera*, in *Saxony*, and of which the first branch issues likewise, as my two companions informed me, from a pool in a *peat-moss*, at the foot of the *Waldstein*; the highest of the eminences belonging to that part of the *Fichtelberg*. The latter river, therefore, has had no greater share than the *Eger* in the excavation of the *vallies* between these mountains.

716. Hence we returned to the forges of *Weissenheid*, where, at four o'clock, M. Sievers and I took leave of M. Waeckler, and proceeded along the left bank of the lake on a causeway of *granitic sand*, which is kept in very good order across the *peat-moors*, and which led us to the small town of *Weissenstadt*, built on a terrace in front of the mountains on this side. It is here that the *Eger* issues from the lake; and notwithstanding the late rains, the water of this river was very clear, having only the brown tint which is common to the water of all peat-mosses when viewed at some depth, but which is not perceived when a little is taken up in a glass. The causeway is carried on through the meadows of this basin, where it winds to follow the firmest parts of the soil, which are those that border the kind of *islands* mentioned above: some of the smallest of these, where the *blocks* could be easily collected on the sides, have been brought into cultivation. Here I saw *blocks* of a *granite* which

contains large crystals of feld-spar, like that of the *Ochsen-kopf*, and of which the masses had evidently belonged to thick strata.

717. We went on towards the small town of *Wunsiedel*, the residence of M. Sievers, within half a league of *Alexanders-bade*, to which place we purposed to proceed that evening, in order to set out from thence the next morning on other excursions. Our road lay over a promontory advancing into the meadows as into a lake; it is parallel with the chain of the *granitic* cones which follow the *Schnee-berg*, and from which it is divided only by meadows; these meadows are indented on their borders by smaller promontories, projecting from terraces covered with *blocks* of *granite*. The great promontory, however, is a mass of *gneiss*, and the blocks and other fragments, which I saw on its surface, were all of that stone. Here then is another very large mass of *gneiss* in a low space, surrounded with *granitic* eminences; and this confirms my conjecture that the *granite* was covered by the *gneiss* antecedently to all the catastrophes which this region underwent. I observed another remarkable phenomenon on this promontory; the *blocks* and other superficial stony masses were imbedded in a very thick loose soil; this soil, however, was not the *granitic sand* of the surrounding mountains, on which *firs* flourish; it was a *fine sand* like that of the heaths, where *pines* only grow: it could not therefore have been brought down hither from the

mountains. This promontory is insulated throughout the greater part of its extent; but, on the right, it joins the chain of the mountains, from which again separating, it takes a different direction; and this interval is likewise occupied by meadows. In these two intervals between the ridge of *gneiss* and the foot of the mountains, are collected all the waters which descend from the latter: those on the side where the promontory terminates fall into the *Eger* below *Weissenstadt*; and those on the other side form the commencement of the small river *Rösla*, which passes through *Wunsiedel*, and having joined the *Rosein*, arriving from the opposite part of the chain, their united stream falls into the *Eger* near *Hohenberg*, not far from the spot where that river issues from the mountains. These then are all the branches of the *Eger*, which afterwards enters *Bohemia*; and no one who has observed the real facts can possibly imagine that it has carried any *stones* out of the whole of this vast space; for the last mentioned branches issue, like the former, from meadows interspersed with *pools*, which they have not been able to fill up with all the materials propelled by their waters since the epoch when they began to flow. This phenomenon is therefore general on the continents at all heights; for on the *Alps*, and on every other chain of mountains, it is absolutely the same.

718. When we passed near *Wunsiedel*, M. Sievers sent hither to acquaint M. KLINGUER, Counsellor

of

of Justice, to whom likewise I was recommended, that we were going to *Alexanders-bade*, which is a large bathing house, surrounded only by a few cottages, where this gentleman came to meet us at half past seven. The mineral spring here is chalybeate, and contains a great deal of *fixed air*, which gives it an *acidulous* taste; whence this place has also the name of *Sauer-brunnen*, (sour springs:) for the baths, the water is heated. M. Klinguer had measured by the barometer the height of the *Ochsen-kopf* and of the *Schnee-berg* comparatively with *Leopolds-dorf*, a town higher than *Wunsiedel* on the course of the *Rösla;* and he found the former eminence to be 1420 French feet (about 1515 English) above that place, and the latter, 1485 (1584 English.) With respect to the height of *Leopolds-dorf* above the *level of the sea*, he had no direct observation of the barometer; but he considered 28 inches as the mean height of that instrument at the level of the sea, and on comparing this with its mean height at *Leopolds-dorf* he had found the level of the latter to be 2697 feet above the former; which, when added to the heights of the two mountains, makes them merely *granitic* hills when compared with the chain of the *Alps*.

Sept. 19*th*. I set out in the morning with M. Sievers and M. Klinguer, to cross a ridge of eminences called the *Luchs-berg*, which is situated between *Alexanders-bäde* and *Wunsiedel*, and by which the line of the mounts on the base of the chain of the

Schnee-berg is terminated on the south, as it is by the *Rollen-stein* on the north. We first ascended a long promontory, covered with large *blocks* on *granitic sand*, which is the case with all those that advance into the meadows of the basin above described, as well as with its *islands*; but I could here perceive that these *blocks* were not merely superficial; for there were in the promontory some clefts, in which I saw that its interior part was entirely composed of blocks.

719. We ascended among these *blocks*, through a fir wood, to the summit of the *Luch-berg*, where we found a large rock of *granite*, with inclined *strata* fractured in many places by its subsidence; in consequence of the fractures, some large masses have fallen down, and form a most picturesque base to this pyramid, which, on one side, is from 60 to 80 feet high. Steps have been cut in the pyramid itself, and in the blocks of the base, wooden ones being fixed in the intervals of the latter; and we were thus enabled to ascend to the summit, where there is a space which has been surrounded with a rail, and measures about 5 or 6 feet in each direction. I cannot express my sensations on reaching this spot, where I could represent to myself, as clearly as if I had been a witness of it, the catastrophe which had taken place in the surrounding region, together with its consequences; especially the prodigious agitation of the water of the sea, when, while this part of its bed was undergoing its latest catastrophe,

masses of equal size with the bordering mountains sunk into the interior caverns, whence they first expelled the air, and afterwards, when they reached the lowest depths, the water which with them had been ingulphed. From the state of these sunken masses, it may easily be understood why *earthquakes*, when their cause is in action, are not stopped by *mountains*. This cause, as I shewed in my first work, is the astonishing quantity of *aqueous vapour* produced by the waters, which, as they circulate through the shattered mass of the *strata*, happen suddenly to fall into those interior furnaces wherein *lava* is formed: there is no action more powerful than that of this *vapour*, when produced in a confined space by a great *heat*; it immediately diffuses itself throughout the whole of the cavernous mass of the sunken *strata*, under the *mountains*, as well as under the *plains*; and the circumstance by which this *agent* is particularly pointed out is, that, after even the mountains have been shaken, no exterior explosion ensues; because the *vapour*, as it passes through these cavities, is gradually condensed, and returns into *water*.

720. From hence there is a better view than from the *Rollen-stein* of the mounts which rise successively on the base of the *Schnee-berg*, and of the others that are scattered in various parts of the basin. My two companions informed me, that, with respect to their general characters, these mounts are all similar to that on which we now stood; most of

them having, on their summits, an insulated rock, indicative of the manner of their formation. All these exterior eminences are the result of interior *obstacles*, which have impeded the *descent* of the *strata*, and on which the latter have been broken. The pyramids on the summits rest on the highest parts of these interior *obstacles*; and the *blocks* forming the mass of the mounts, as well as all the rest that are scattered on their lower parts, are fragments of the strata which have been expelled from within by the *expansible fluids*.

721. The *Luchsberg* is attended by more remarkable circumstances than the other eminences of the same kind, and it is partly on this account that strangers are taken to see it; but besides, art has concurred with nature in embellishing it. This eminence is situated at the extremity of two ridges of similar mounts; and on the side where the greatest subsidence has taken place, the ground is lower than in the part where these ridges unite; but nothing can be more astonishing than the side of this eminence towards *Wunsiedel*; masses not inferior in size to houses seem there to have fallen from the sky, some being composed of several *strata*, which still adhere together, while in others, the *strata*, though separated, have remained near each other in many various positions, forming on the slope very picturesque associations, especially *grottoes*; and of these I shall first describe the largest. In the *subsidence* whence this chaos resulted, one piece of a

single stratum, the surface of which M. Klinguer had found to be about 1000 square feet, happened to be left supported by other *blocks* in a situation nearly horizontal, its anterior part resting on one of these masses, which renders it firm. This particular accident, together with several others of a similar nature, suggested to the inhabitants of *Wunsiedel* the idea of converting this scene of disorder into a pleasure-ground. With this view, they began by clearing the space beneath the large *block*, which thus forms the roof of a vast circular saloon; they then filled up with stones the intervals of the masses that support this roof all around, only leaving passages on both sides of the *block* on which it rests in front, and which is situated so far within, as that there is all around it a large space sheltered from the rain. This saloon is furnished with handsome stone benches; and the pillar near the entrance forms the centre of a table. To all who make parties of pleasure to the *Luchs-berg*, and especially to those who lodge at the baths, this is a very agreeable place of retreat in hot weather, or when it happens to rain; but there are around it many others which are equally pleasant.

722. Fir-trees flourish extremely in this amphitheatre; for they not only spring up in the intervals of the blocks, but many of them, having been favoured in their first growth by the lichens and the mosses, which overspread the projecting parts of these vast fragments, and retain the granitic sand washed down

by the rains from above, have thrown their roots around the blocks, and have risen to a great height, with the appearance of being placed on pedestals. Several safe ascents have been made, on different sides, to the top of this ampitheatre, by means of rails fixed to the trees; steps have been cut in some of the *blocks*, and are continued in their intervals by wooden ones; and in this manner different spots are rendered accessible, where, under large *blocks* like that which I have just described, not only several grottoes, but even spacious apartments, have been constructed: one of these is large enough to be used sometimes as a theatre; and another near it serves as a dining-room for the companies assembled on those occasions. Between all these masses, there are paths of communication, which form, in this singular labyrinth, a variety of pleasant walks, where those who resort hither may at any time find rest in the shade, or shelter from the rain. In one of these grottoes I saw the first example of a vegetable phenomenon, which I shall describe, because there are probably many botanists who may not have had an opportunity of observing it.

723. My two companions, placing me on one side of the entrance of this grotto, told me to look in towards its farther end, where I perceived nothing but a heap of blocks which seemed to be covered with a grey dust; but what was my surprize, when, on being led to the other side of the entrance, I saw these same blocks shining with a *green light* of sin-

gular brilliancy, like that which may sometimes be caught in viewing a piece of *Labrador spar* in a particular direction. I went up to these stones, and found them covered with what appeared to be a kind of down; but on taking off some of this, in order to examine it in the full light, I perçeived that it was composed of small laminæ, which had serrated edges, and were as transparent as a pale green glass. But it is not immediately by this transparence that the phenomenon is produced; for, as the inner part of the grotto is dark, no light can proceed thence to pass perceptibly through these laminæ; it is an effect of refraction, as is the case with respect to the *eyes* of a *cat* in a dark place, when the exterior light happens to strike on them; and the light which thus returns from the moss is of a *green* incomparably more vivid than is observed immediately by transparence. In all my excursions among mountains, I have seen only one other instance of this phenomenon, which is in a cavity of the *Botter rock* on *Dartmoor* in *Devonshire*, where I have described it in my Travels already published; and the latter example shews that this species of *moss* does not belong exclusively to *granitic* grottoes; for the *Botter rock* is composed of a kind of *basalt*.

724. As, in my journey into *Lusatia* and *Silesia*, I had seen, among the scattered mounts of *granite*, *schistus*, or *gneiss*, some others of which the summits were of *basalts*, I inquired of my two companions whether the case was the same in this country; they

replied that it was, and pointed out to me, along the right bank of the *Eger*, the mounts of *Thier-stien*, *Neuhauss*, *Stein-berg*, and *Hohenberg*, (the last being near the entrance into *Bohemia*,) which all had *basalts* on their summits. This is a very remarkable phenomenon; but a full investigation of it would be attended with great difficulty, because all the slopes of these mounts, as well as the circumjacent grounds, are so much covered with rubbish, that repeated excursions to them would be necessary, for the purpose of discovering, in some place, the junction of the different mass; nor even could it always be supposed, considering the frequent subversions of the *strata*, that those, which are now the uppermost, were originally superior to the others. In the sequel of this journey, I shall often have occasion to mention eminences and other soils of *basalt*, and to add some farther conjectures on the subject.

725. From the summit of the *Luchs-berg*, I saw the *Naab* flowing in the *upper Palatinate*, below the point at which it issues from behind the chain of the *Schnee-berg;* and I again observed several *pools* and small *lakes* on its course. Generally speaking, M. Humboldt's topographical map, given to me by Baron Von Hardenberg, contains no *streams* which do not either proceed from *pools*, or pass through such cavities in their course. My readers must not be surprized at my returning so often to the same point; because, as this is a phenomenon which shews how small a quantity of materials has been

transported by *running waters*, there is no other way than by multiplied examples of it at every height, and in many different countries, to vanquish the long established prejudice, that the *vallies*, together with all other clefts and inequalities of the surface of our continents, have been produced by streams; an opinion which, in a greater degree than almost any other, has diffused obscurity over the whole science of geology, and has given birth to errors of many different kinds.

726. We had intended to make another excursion this same day; but the rain, with which we had been threatened the whole morning, at last came on; we retired into the large grotto, where we dined on some provisions that we had brought with us; and after we had waited there some time without seeing any probability that the rain would cease, we returned to *Alexanders-bade*.

Sept. 20th. This being the place at which I had appointed my carriage to meet me, I continued my journey from hence with post-horses, my first stage being to *Egra*, a town belonging to *Bohemia;* and M. Sievers accompanied me a little way on the road, in order to point out to me some interesting phenomena in a *schistose* ridge which here crosses the basin, and which, beginning near *Wunsiedel*, where all is *granite*, follows, at some distance, the left bank of the *Rösla*, down to the point where that river falls into the *Eger*. We first returned towards

Wunsiedel, in order to cross this *schistose* ridge, the direction of which is followed by the villages of *Holenbrunnen*, *Singenten-grün*, *Göpfers-grün*, and *Thiersheim*. The strata of this ridge descend in an angle of about 45°. towards the course of the *Rösla*, and it is attended by the following remarkable circumstances. In the first place, within its breadth are contained two *lagen*, or *masses of strata*, of a very white saline or statuary *marble* with a shining grain, which would equal the *Carrara*, if its *strata* were thick; but they are too thin to be used except for tables, mantle-pieces, and purposes of that kind. These strata are transversely divided by many fractures, and they have slipped down irregularly between the *schistose strata*, where they are consequently found at different levels. But the circumstance most singular, and most evidently shewing the great variety of the operations which took place on the bottom of the *ancient sea*, is that the spaces left vacant between the *schisti*, by the slipping down of the *marble strata*, have been filled with a *clay* containing *concretions* rich in *iron*, which are smelted on the spot, for the purpose of extracting that metal. There are but few places where the *marble* appears externally; and in those chiefly it is worked. The *clay* is in the intervals of the highest masses of the *marble*, and rests on the upper sections of such as, having been separated by fractures from those above them, have slidden downwards in a greater or less degree. This *clay* is worked by shafts, in order that nothing may be taken out, except the ferruginous *concretions;* and when a lateral mass of *marble* occurs, it is worked by the same shaft across its breadth. M. Sievers took the trouble to point out to my observation all which I have here described, as we passed several places where the work was going on; and at *Singenten-grün* I parted with this gentleman, by whose assistance I had been enabled to view, in so short a time and so advantageous a manner, a country thus interesting to my views.

727. In proceeding along the road by *Bernstein*, and *Stemmers-grün*, I crossed several of the hills which resemble islands in the tract of meadows formed on a soil of granitic sand; and as I descended the last of these hills to *Thiersheim*, I again saw the section of the *marble strata* appear at the surface. I afterwards passed over hills covered with *loose soils* of different kinds: on some of these I observed the same *strata* of *white sand*, which I have already mentioned as absolutely extraneous to the *stony strata* of the hills themselves and the surrounding eminences, and which are intermixed with *strata* of *yellow sand* and of *clay;* they are such, in short, as are found in many plains; and hence it is evident that they must have been formed on the bed of the sea before the birth of the continent. In several places, I saw abundance of *blocks* on the surface of these soils: the first that I observed were of the *saline marble*, intermixed with others of *quartz;* afterwards, the latter were mingled with some apparently of the *grün-stein*, of which no *strata* are seen

externally throughout the whole country; and lastly I saw amongst them *blocks* of *sienite* covered with a yellowish crust.

728. From the last of these hills, which is above *Schirnding*, and still within the basin encompassed by mountains, we had a view of the course of the *Eger* in its way into *Bohemia.* This is an open country, the lower part of which is interspersed with mounts, and cultivated. On the left are the *Steinberg* and the *Hohen-berg*, both with *basaltic* summits. At *Schirnding*, the *Rösla* issues, by a cleft from the valley in which it has for a long way freely meandered through meadows: after I had here crossed it by a high bridge with a single arch, I proceeded along a road cut in the slope of the hills on the right. Below the bridge, the river enters a large space, where it formerly held a desultory course, sometimes beating against one side, and sometimes against the other. This operation is shewn by the *cliffs* which were formed in the parts attacked by the river; but at present the stream preserves a permanent channel, winding through the meadows, and the ancient *cliffs* are reduced into slopes covered with grass. It is in this space that the *Rösla* joins the *Eger* at *Fischerne,* and they afterwards flow united along the same vale, over which the latter also formerly wandered as I have above described: on the left bank there is a large *cliff* principally composed of loose soil covering ruins

of *schistus*, some rocks of which I saw projecting from the cliff, now reduced into a grassy slope.

729. The first village to which we came after we had entered *Bohemia*, is called *Mühlbach*, on account of a brook arriving here from the hills on the right, and turning a mill at this place. Hence I proceeded over those hills, following the direction of the *Eger*, which I saw from time to time continuing its meanders in the meadows. The whole country here within view on the outer side of the *Fichtelberg* consists of cultivated hills, extending as far as to other mountains at a distance, which are much intersected, and from which project several promontories, that descend gradually, and are lost among these hills. On the road, I observed *blocks* of *quartz* in great abundance, all the way to *Egra*, where I arrived at three o'clock. Baron Von Hardenberg had here recommended me to M. LIMBECK VON LILIENAW, the burgomaster of the town, requesting him to furnish me with directions and recommendations for the rest of my journey through *Bohemia;* and I was accordingly obliged to this gentleman for affording me much assistance, as well as for procuring me that of Dr. KÖHLER, who, being a native of *Aussig*, a place through which I intended to pass in my way from *Bohemia* into *Saxony*, was so good as to give me a letter to his brother residing there.

730. I had been desired, when I should be at *Egra*, to observe a phenomenon near a spot where there are baths, of which I received an interesting account; and on inquiring about it at the Sun inn, where I was lodged, the innkeeper's son offered to accompany me thither. We set out from *Egra* at five o'clock, and first crossed the river, in a part where it flows between the town, and a hill which has a *schistose* base, but is covered with a loose soil of such thickness, that the *schistus* appears only at the foot, whence it is taken to be used as building stone, being very hard. When we came to the highest part of the hill, we had a prospect on the right of a large plain, where the bathing-house is situated. The hill is covered with heath, on which the sheep browze; and I saw on its surface abundance of *blocks* and other fragments of *quartz*. This plain has the name of *Cammer;* the hill slopes gradually dawn to it; and a small eminence rising on it, called *Cammer-hügel*, was the object of my present walk.

731. Having ascended the base of this mount on the side on which I had approached it, I entered a lateral cavity, at the level of the base, encompassed by the section of very distinct *strata* of the soil rising around it with an inclination to the right, where they follow the slope of the mount. This cavity had not been produced at any very remote period; I could not learn the date of it; but no doubt could be entertained of its having been the effect of an *interior*

interior fire. These very regular *strata* were alternately of *clay* and of *basaltic* fragments; but they had evidently undergone the action of fire throughout their whole thickness; the *clay* had assumed the hardness and the colour of brick, and the *basaltic* fragments were reduced into scoriæ; I should have taken them for *volcanic cinders*, had they all been within two or three inches in diameter, because, in such as did not exceed that size, it was evident that the action of fire had pervaded their whole mass; but there were among them some larger fragments, in which this action not having penetrated to any greater depth, the inner part was simple *basalt.* The summit of this mount consists of a rock of *basaltic* stone, which has not the form either of *prisms* or of *balls;* and it is from this point that the *strata* just mentioned descend to the level of the plain.

732. It will be asked how far this phenomenon may be considered as supporting the opinion that the *basalts*, which will be found to abound so greatly in this country, are a *volcanic* product. I will not speak decisively on this question, although I incline to the affirmative. It is known that *lavas*, which have descended from *Etna*, on entering the sea, have there separated into *prisms.* On this circumstance, combined with several others, I founded the opinion expressed in my first work, that the *basalts* scattered on our continents are the product of *lavas* which burst forth at the bottom of the *ancient sea;*

and I shewed, at the same time, that, on many of these *lavas*, *strata* of *lime-stone* had been subsequently formed. But the action of *fire* on the superficial *strata* in the neighbourhood of *Egra* requires for its solution some additional circumstance. I have already explained in what manner it is rendered evident by *earthquakes* that the *combustion* and *liquefaction* of the *matter* of which *lavas* are formed extend under vast tracts of our *mineral strata*; I proved also, in my first geological work, that this matter is beneath all the *strata*, and is extraneous to them: now may it not have happened that, in the great catastrophes of the *strata* occasioned by their subsidences in *caverns*, the matter, which undergoes this subterranean *combustion*, has been raised in some places, to within a small distance of the surface, so as to have communicated its heat to some of the exterior *strata*, and has thus become the cause of the effect which I have just described? However this may be, the phenomenon itself is a very remarkble one. A heavy rain came on, while we were upon the *Cammer-hügel*, so that I could not stay there as long as I should have wished, but was obliged to hasten back to *Egra*. (In the country, this town is called *Eger*, as well as the river.)

Sept. 21*st.* I set out from *Egra* at half past seven in the morning, and my first stage, in length three miles, was to *Tzwoda*, where I did not arrive till half past 12. In passing through the town of

Egra, I saw that it was paved with *white quartz* and *basalt*. Along this road, I was continually ascending and descending hills composed of *micaceous schistus*; though this indeed appeared only in some projecting rocks and deep clefts, these hills being covered with a very thick loose soil, which is intermixed with *gravel* and *blocks* of *quartz*, though still in the vicinity of the *granitic* mountains of the *Fichtelberg*. The *Eger* winds in vales covered with meadows, where I frequently passed very near it; and in the intervals I crossed several brooks which flow through similar vales to join it: at last I crossed the river itself in a part whence it makes a wide bend to the right, and I did not see it again till I was near the end of the stage; but, in the mean time, I passed over several other vales of the same nature, with brooks flowing in them, which fall into the river lower down. Here then we have a new *system of waters* forming a *river*, the *branches* whereof cannot be supposed to have hollowed out the *vales* through which they pass; they must have found these cavities in their course when they began to flow, and they have *levelled* the bottoms now covered with *meadows*.

733. In passing over the tops of these hills, I saw, at no great distance on the left, the chain of mountains which separates *Bohemia* first from the country of *Bayreuth*, and then from *Saxony*, where it is called the *Ertz-gebürge*. This chain is very little calculated to support the idea of that *elevated*

sea, which is supposed by some of the German geologists to have formerly covered *Bohemia*, being kept up at that high level by a dike; for the whole chain is intersected with *vallies* so deep, that their bottom is as low as that of the *vales* between the hills. In one of these vales, besides the masses of *quartz*, I saw some large *blocks* of *granite* belonging to *strata* of no great thickness, which are cut here, as I have described near *Weissenheid*, for the frames of the doors of houses and gardens. In a vale succeeding this, I found a great many *blocks* of a very hard *sand-stone*, covered with a crust of a reddish brown: some of these still preserved their angles, but others were rounded, and the widest of their surfaces were concave. The hills becoming very rapid, I walked up the next, on the slope of which I found no *blocks* except of *white quartz*; but on the summit I again met with those of the *sand-stone*.

734. Hence I descended into another vale; and finding the hill beyond it very high and steep, I walked up this also. I was here struck with the variety of the *blocks* which covered the surface: at first those of *basalt* chiefly prevailed; but they gave place, as I ascended, to others of *white quartz*, and *granulated quartz*, or very hard *sand-stóne*; and at last I saw a great many masses of a *breccia* composed of fragments of *white quartz*, some angular, and others rounded, imbedded in a hard substance which was variously shaded from a blackish

to a reddish colour, or grey. The fragments contained in this *breccia* were of different sizes, and were so small in some of the masses as to give them a resemblance to *porphyry*. Seeing that the summit of this hill was clothed with woods, I thought that there might possibly be on it some *basaltic* eminence; but I did not find any; it was everywhere covered with a loose soil, mixed with the different kinds of stones which I have mentioned, and with some *basalts;* and this was the case over the whole summit, and part of the opposite slope; then by degrees the *basalts* disappeared, and there remained only the other kinds of stones.

735. The size of the vale, or small plain, in which I again came to the *Eger*, and that of the higher vales whence issue the brooks arriving to join this river, are proofs that nothing either has changed or can have changed in this country, since *streams* were first formed in it by the rain-waters. It was by successive *subsidences* on the bottom of the ancient sea, that these *hills*, with their *vales*, were placed below the level of the bordering *mountains*, which are composed of the same *strata*, and do themselves, by the state of those *strata*, very clearly shew that they have sunk from a higher level. The *air* compressed within, during the *subsidences*, was the agent which ejected, through various crevices, these masses of so many kinds of *strata* not externally appearing; and the masses of *breccia*, indicate anterior convulsions, in consequence

of which the fragments of the shattered *strata* having been dispersed over the bed of the sea, they were here consolidated in *stony strata*, while in other places they were disseminated in the *loose strata* which form the surface of so many soils.

736. Beyond this hill, I came to the small plain mentioned above, in which the *Eger* flows, having entered it from the right. In this plain is the town of *Falkenau;* and when I had passed through it, I entered a vale, partly cultivated, partly in meadows, through which a brook takes its course to join the *Eger*. On the right, the country rises in rounded hills; the cultivated parts of their rapid slopes were still filled up with the water of the rains of the preceding days, which there was turbid, but became limpid on reaching the grassy parts; because as its course was impeded and divided by the blades of *grass*, it deposited between them the earthy particles which it had thus far brought along with it, at the same time raising the soil by this deposition. It is for this reason that, since the eminences have been clothed with vegetation, the rain-waters have made less impression on them, than was the case for some time after the birth of our continents. There are *basalts* on the summits of these eminences, but I saw none on their slopes; the *blocks*, of which there is a great quantity, are of a grey *granulated quartz*, or very hard *sandstone*. The shades of difference among stones of

this class are so various, that their nomenclature is still very arbitrary.

737. *Tzwoda* lies in the vale which is bordered by these eminences; I arrived there at half past 12, and set out again at two for *Carlsbad:* this latter stage is only two miles in length; but three are charged at the post-houses, on account of the badness of the road; and in fact I was four hours in travelling it. In the way, I continued to pass over hills separated by vales covered with meadows, the waters of which discharge themselves into the *Eger*. From the first of these hills, I had a distant view of the river flowing in a valley higher up on its course, and then entering a deep cleft at the foot of the mountains: it cannot have formed this cleft, because it has a sufficient space to spread above; it must therefore have found this passage open to receive it, at a lower level, when it began to flow; which will yet more plainly appear at the point of its issue.

738. In the interval where the *Eger* was concealed from me by the depth of this cleft, I crossed two remarkable hills; unluckily it was raining, so that I could not quit my carriage, nor see the objects distinctly except at a small distance. In ascending the first of these hills, I went up a very steep side, which was of great extent, and was covered with *blocks* in no less abundance than the ter-

races near *Wissenheid;* these blocks being overspread with *lichens*, I took them at first for *granite;* but as I proceeded, I sent the postillion occasionally to strike off fragments of them with a hammer which I always carried about me when I travelled; and he brought me first pieces of a very hard white *granulated quartz*, and then, after successive intermediate degrees of induration, some of a *sandstone* of which the surface, to the depth of three or four lines, was of a rusty colour. The following *blocks*, though externally they appeared the same on account of the *lichens*, were of a *breccia* containing large fragments of *quartz*, imbedded on a very hard substance. Lastly, all these various kinds of *blocks* were lying on a coarse *sand*, which might have been mistaken for *granitic sand;* but it was entirely composed of small crystals of *white quartz;* I saw some pits where it was dug: there were among it some concerted masses which were taken out whole, but were easily broken with the hammer.

739. The upper part of this hill was of considerable extent, and much intersected; I saw on it the same *blocks* as on the slope by which I had ascended to it; but, as I descended on the opposite side, they soon diminished in number, and at last disappeared. The whole of this latter side of the hill is cultivated, and slopes gradually down to the level of a vale, along which I travelled for some time; I then went up the other hill, on a side much broken and covered in many parts with the same kind of *blocks*,

lying on the same soil of coarse *quartzeous sand*, as I had observed on the rapid side of the preceding hill. This repetition of the same phenomena in two ridges of hills which have their homologous faces turned in the same direction, with the same circumstance, that their *steep* sides are covered with *blocks*, while there are none on those that form *gentle slopes;* the vale also, which separates these hills, and which from its breadth and depth, cannot have been a channel for the transmission of the *blocks* to the rapid slopes; lastly, the *blocks* themselves, which do not belong to any *strata* externally appearing; all these phenomena, I say, concur in determining the catastrophes that must have taken place in this spot. Throughout the whole extent of this region, the *strata* have *subsided;* the *vale* shews the direction of the principal *subsidence;* the *abrupt sides* mark the lines of the *fractures* at the points of direct *subsidence;* the sides with *gentle slopes* have been produced by the *angular motions* of the strata; and the *blocks* have been expelled from within in the spots where great *subsidences* have taken place in the front of *fractures.*

740. After having crossed the second of these ridges, I met with *blocks* and smaller masses of *granite;* some of them were grey, with large crystals of *feldspar*, and others reddish, with very small crystals; *blocks* of *breccia* were everywhere intermingled with them. I afterwards found the road paved with *basalts;* but a more wretched

pavement cannot easily be imagined, It had formerly been made to improve the road; but it was in such a state when I passed over it; that my carriage would have been broken in pieces, if the postillion had not driven as slowly as possible. I saw here and there, in some inflexions, an argillaceous soil, which appeared to have been produced by a decomposition of *schistus*, being interspersed with laminæ of that stone.

741. At last I recovered sight of the *Eger*, at its issue from the long defile at the foot of the mountains, into which I have mentioned its entrance at a higher point; below this, it continues to flow in the same direction, having here, as well as above the defile, an open soil covered with meadows on the left; it cannot, therefore, have exerted any effort to cut its way through the foot of the mountains, but must have found this passage already prepared for it when it began to flow. After it has issued forth, it takes its course along an abrupt side, which is the continuation of the right bank of the defile, and forms the foot of some *granitic* eminences; from the appearance of the ground, I could judge that the *strata* passed under the hills which I had just crossed, and which I had found to consist externally only of loose soil, mixed with *blocks* of many different kinds, and particularly, on a part of the last hill, of various species of *granite*, some of which do not appear in the exterior *strata*. The *plain* is the result of a great *subsidence*; but during

this

this catastrophe, the parts remaining at a higher level must have undergone violent shocks, and must themselves have subsided, though in a less degree. Before the latest catastrophe took place, large spaces of the surface of the *stony strata* had already been covered with *loose strata* mixed with fragments. In parts where these *loose strata* are of a great thickness, there are wide and deep clefts, the sides of which are reduced into *slopes*, and covered with *grass;* but wherever such clefts have been made in the mass of the *granite* itself, but with little *loose soil* on the surface, the sides have remained *abrupt*, and exhibit *sections* of the *granitic strata* in very great disorder. Lastly, there are some very large double fractures so deep that all the intermediary masses of *strata* have totally disappeared; and in one of these *Carlsbad* is situated.

742. Before I came to this double fracture, which has formed a valley, I crossed the *Eger* at a point, where, after having wound freely through the meadows at the foot of its steep bank on the right, it is repelled by a promontory advancing from that bank; and being thus obliged to bend its course across the open space, it afterwards flows on the opposite side. This promontory, like the hills over which I had travelled before, is composed of loose strata; the river, having attacked it from the first, had formed a cliff here; but the large materials falling from it being accumulated at its foot, the stream was consequently forced to retreat, and the

cliff has since been reduced into a slope, which is covered with grass, except in one part, where I could perceive that it was still attacked by the river during great inundations.

743. On arriving in front of the entrance of the valley within which *Carlsbad* stands, a very striking scene presents itself; this valley is at first narrow, but afterwards it becomes wider; its abrupt sides are covered with firs; and among these rise large pyramids of granite, forming a magnificent frame to the town, which ascends in an amphitheatre in the centre of the picture. A small river called the *Töpel* issuing from this space, and proceeding to join the *Eger*, is crossed by a bridge at the entrance of this valley.

Sept. 22*d.* I had a recommendation from M. VON LILIENAW of *Egra* to M. MAYER, chief Magistrate of *Carlsbad*, whose son was so good as to accompany me in my first excursion in the neighbourhood, an account of which may serve to convey some idea of the picturesque scenery produced here by the catastrophes of the *granitic strata.* We ascended a pyramid of these *strata*, which projects from the slope of the left bank of the *Töpel*, and commands the town.

744. This pyramid is called the *Hirsch-stein*, (Stag-rock,) and from its summit we overlooked some of the surrounding hills. When viewed from

the heights, this valley presents very much the same appearance as that of the *Wiesent;* but there the rocks consist of *strata* of *lime-stone* which contain *marine bodies;* and it is interesting to see the same phenomena in *granitic strata.* Besides, as *Carlsbad* is a place much frequented on account of its baths, and as the bathers here are required to take a great deal of exercise, the description of the geological phenomena which may be observed in the vicinity, will add new interest to the walks and rides of those who may happen to read it; by pointing out to them examples of the various kinds of monuments now remaining to us of the events that have happened on our globe, and more particularly by proving, that all the catastrophes, of which there are visible traces on the surface of our *continents,* took place before these continents were abandoned by the *sea,* and consequently before the *rivers* began to flow on them.

745. Nothing contributes more to the picturesque appearance of this place, when approached from the valley of the *Eger,* than a church handsomely built, which rises in the centre of the amphitheatre formed by the town, and is the first object that meets the eye between the romantic sides described above. At first sight it could not be supposed that from this space there was an opening into any passage by which it was possible to proceed farther; but, on ascending the course of the *Töpel,* this stream is seen to issue from a defile on the right, and to turn

round a promontory on which the church is built: it then takes its course between the town, and the abrupt side on its left bank, flowing among large masses of stone; on a superficial view, it might be supposed that these masses had been brought down hither by the stream; but we soon found a proof to the contrary; for having ascended the defile, we came into a small plain covered with meadows, in which the *Töpel* flows, after issuing from another defile above. Now it is evident that in this plain the river must have deposited whatever it has been able to bring down from the higher parts of its course; since this is a wide space, in which it cannot have any rapidity; and in fact, for a long time, it has not spread here, during its inundations, any thing more than *sand.* The meadows have even advanced into the defile, on the *Carlsbad* side; and a part of the town, which extends along the left bank of the river, bears the name of *Wiese*, as having been formerly *meadows.* On one side of this interior basin stands the assembly-room, whence begins what is called the *Alley ;* this is a plantation of trees in the lower part of a large *combe*, which is itself covered with wood, and through which the walk is continued up to the top of the hills.

746. From the summit of the *Hirsch-stein* I found it easy to comprehend the nature of the catastrophe which has happened in this spot: two principal fractures have here taken place, at some

distance from each other; and the intermediate mass has irregularly subsided, inclining from the plain on the left, towards the valley of *Carlsbad* on the right. In this valley, the sides of both the *fractures* are abrupt, and are interspersed with pyramidal rocks. One of these rocks, which projects from the slope on the opposite side of the valley, is called the *Three Crosses;* indeed it very much resembles the *Calvaries* so common on the continent. The *Hirsch-stein*, though lower than this rock, rises to the height of several hundred feet above its own base on the side next the river; its *strata* are nearly vertical in the part where they remain united; but its base is formed by large masses which have fallen from it, and which give it the appearance of an obelisk; between these masses, low walls have been built, in order to render it more firm. Winding paths have been cut here, and other means contrived, to facilitate the ascent to the summit, on which there is also a cross, with a rail to guard the brow of the precipitous sides of the pyramid, that they may be looked down upon with safety. From this summit, the inflexions of the hill behind the rock enabled me to judge, that the *strata incline* towards a point of *subsidence* less considerable than that whence the valley of *Carlsbad* resulted; for on the opposite side of this hill there is another valley, the bottom of which is formed by a large mass of *strata* entirely *sunken* between two irregular *fractures*.

747. I afterwards walked up the town on the right bank of the river, where the houses are built so near the foot of the rocks, that the latter have been cut away, in order to procure a little space behind these houses. I could here see, that, though this side of the valley is higher than the other, it has however also *subsided*, with similar accidents; its *strata* present their *section* above, and descend, turning their plane towards the higher end of the valley; and as, in different masses, they have different degrees of inclination, it may be judged that there are interior fractures, independently of the clefts which externally divide them.

748. I shall not enter into any details respecting *Carlsbad* itself, or the waters of its baths; it is a place which has been often described, and I think I have said enough of its geological phenomena, to recall its scenery to the memory of those who have been there, and to awaken the attention of others who may visit it hereafter. I set out from hence at half past 12, and took the road to *Topliz;* my first stage being to *Buchaw*, four miles distant, where I arrived at four o'clock. I first ascended the hills on the right bank of the *Töpel*, and above the rocks, I found their summits cultivated. I have already said that most of the summits of these hills are covered with a very thick loose soil; but here, above this soil, rise parallel ridges of *granitic* rocks, in which the *strata* present their section at the top, and are strongly inclined inwards. When I had reached

the highest point of the hill, I saw on the right a vast *subsidence* in the form of a half tunnel, the interior surface of which is cultivated down to the bottom, where it terminates near a cleft in the rocks forming a part of the enclosure of that space covered with meadows, through which the *Töpel* flows in its way to *Carlsbad.*

749. Having proceeded some way farther on this summit, I came to the head of a large *combe* with a rapid declivity, the bottom of which was covered with meadows; and here, notwithstanding the heavy rains of the preceding days, there flowed only a rivulet; for *combes* cannot retain any water but such as falls immediately from the air, or trickles down from the springs on their sides: the sides of this combe, however, were in all respects similar to those of the *vallies,* being abrupt and beset with rocks, between which fir-trees were growing. From its lower part, I ascended a hill, and afterwards entered a high vale, the bottom of which is covered with grass and a little marshy, because the water does not run off from it entirely. In this vale I found an immense quantity of *blocks* of *granite,* some of which were very large. After several inconsiderable descents and rises, indicating only that, during the general *subsidence* of the *strata,* some of the masses had sunk to a greater depth than others, I came to a high plain, of great extent and all cultivated, on which are two large insulated *mounts:* the mount most distant from the road is in

the form of a very regular cone, but it was covered with grass from top to bottom, having only on its surface some projecting rocks, the nature of which I could not distinguish, because of the distance: the nearest mount was a large rock of *granite*, encircled with a village, and crowned with an ancient castle, which the postillion told me was called *Eineberg*. No cause that has been in action since the continent has existed can have produced these two *insulated mounts* on the highest soil throughout a great extent of country. In this elevated plain, the *granite* is very near the surface, and is seen in the sides of some small eminences, which have been cut for the purpose of levelling the road.

750. I afterwards crossed several hills, and in one of them I again met with the kind of *granite* which is easily decomposed: its surface is very soft, but I saw its *strata* in the sections on the sides of the road; these *strata* incline inwards, but irregularly; wherever the sections are at a certain height, they moulder down, and fall in masses, which break into separate grains, when struck with a hammer. The whole soil, to a great distance, consists of this *granitic sand;* yet, without any change in it, I suddenly saw the road covered with fragments of *basalt*, and bordered with basaltic prisms. Remarking, near the road, an eminence of a conical form, from 20 to 25 feet in height, I suspected that it might be the source of these *basalts;* and quitting the chaise, in order to view it

more nearly, I found that in fact *basaltic prisms* were taken from its foot, the largest and most entire of which were reserved for bordering the road, and the rest were broken, and thrown on the surface.

751. For some way beyond this, the soil of the hill continued to be of *granitic sand;* but at last it changed, and I saw nothing but fragments of *basalt* on the surface of the fields. Many *cones* here rise on the nearly horizontal soil; observing one of these cones near *Buchaw*, which is situated in a vale, I ascended it, while the horses were changed: it was entirely covered with grass, except here and there, where some rocks appeared, composed of vertical *prismatic basalts;* in walking round this cone, I saw likewise several *prisms*, the upper extremities of which rose some inches above the grass.

752. At a quarter past five, I set out from *Buchaw* for *Libkowitz*, at the distance of two miles, and arrived there at eight o'clock. The road, which is a causeway carried on in a strait line, rises and descends, according to the inflexions of the ground. The soil here is cultivated; and for a long time it consisted of a brownish earth mixed with basaltic rubbish, the latter being still used for gravelling the road; but it changed, on a slope of some rapidity, which I descended towards a vale, where I saw several projecting rocks of *micaceous schistus*,

Having crossed the vale, I ascended a hill of the same *schistus*, the rubbish of which was now mingled with the soil: *blocks* of this stone lay along these fields, and on the borders of the road, where they were intermixed with *blocks* of *granite*. But as the *basaltic* mounts have been seen to commence in the soil of *granitic* sand, so they continue to appear in these soils of *schistose* rubbish. In a part where the causeway was carried over a mount of this kind, I saw *basalts* on both its sides, which had been cut down to some depth; its surface also was still covered with *basaltic* fragments; but at last I saw it gravelled with fragments of *quartz*. Here the light failed me; and I could discern nothing farther till I reached *Libkowitz*, except that there was no change in the nature of the soil, and that the causeway, of which great care is taken, was all the way bordered with heaps of fragments of *quartz* brought thither for the purpose of repairing it.

753. It is evident that, since the continent has existed, no cause can have produced so many changes of soil on these successive hills; but the attention is here more particularly excited by the *basaltic cones*. Cones naturally recal the idea of *volcanoes*; now those of real *volcanoes* have been formed by *lavas* flowing from their summit, and by showers of comminuted scoriæ (commonly called *volcanic cinders*) thrown from their crater: but this is not the manner in which these cones have been

formed; for, with respect to the construction of their mass, they differ in nothing from the cones or pyramids of *granite*, *schistus*, and *gneiss*, among which they are found. Now this appears to agree with my idea that *basaltic lavas* issued forth on the bed of the *ancient sea*, where, when they had cooled, they entered into the class of *solid strata*, and afterwards participated in all the catastrophes, fractures, partial subsidences, and angular motions, to which, as I have heretofore explained, the pyramidal mounts of every other kind of *stratum* owe their origin. As for the connexion between the bases of these different pyramids, it cannot possibly be discovered, because it lies at too great a depth below the surface, which is covered with their rubbish.

Sept. 23*d.* At half past six in the morning, I set out from *Libkowitz* to *Podorsam*, distant two miles, and arrived there at half after nine. I proceeded for some time on the same causeway, across a country consisting of *argillaceous strata;* in general, these are reddish; but some that are bluish are intermixed among them. In those parts where, in order to soften the declivities, the road has been cut to a considerable depth, sections of these *strata*, sometimes horizontal, sometimes inclining inwards, appear on the sides. This combines with all the other very numerous examples which I have already had occasion to adduce, in proving, that, before the *stony strata* underwent their latest catastrophes, they had been covered with the *soft strata*, which consequently participated in the same catastrophes.

754. This excellent causeway, which I had followed for some time, is the high road to *Prague;* and I was sorry when I was obliged to quit it, and turn to the left, the roads across these argillaceous lands being in very bad condition after the late rains. I now descended into a vale, beyond which I crossed two ridges of hills perfectly similar to each other in their nature and their form; they consisted externally of a very thick *loose soil,* covered with abundance of *blocks* of *granite*, of *granulated quartz*, and of *breccia*, intermixed with *basalt;* in both these ridges, the side on which I ascended was very rapid, and the loose soil was there so deeply furrowed by the rains, that I saw beneath it *strata* of a reddish *sand-stone*, which, in different places, were differently *inclined;* while the opposite side of each ridge extended to a great distance in a gentle slope. I have already described many of these parallel ridges, each of which is steep on one side, and slopes gradually downwards on the other, the homologous sides being turned the same way: an indication of parallel *fractures* of the *strata*, following the direction of interior *caverns*, towards which the separated masses assumed an inclination breadthwise.

755. After I had crossed the vale at the foot of the last of these hills, I found a great change in the form and nature of the ground; I ascended another hill, in which the gentle slope on one side was no longer contrasted by a rapid declivity on the other, both slopes being equally gentle; the soil here was of *sand,* mixed with *granitic* rubbish; which occasioned a great improvement in the road. The ground continued to rise for a considerable way, though with many inflexions; some deep clefts afforded me a sight of *strata* of grey *sand-stone,* much fractured, and in great disorder. There were many *blocks* of *granulated quartz* at the surface; and on the summit they lay in such quantities as to have prevented cultivation. This high ground is surrounded by mountains; their line appeared at first to be continuous; but, as I advanced, they began to separate into pyramids, which, as I perceived when I passed before their intervals, were the extremities of angular ridges extending behind in nearly parallel directions. Through these intervals, I saw a distant chain of mountains so high, that their summits were at this time involved in clouds. This was the chain of the *Ertz-gebürge,* which is followed by that of the *Riesen-gebürge* or *Giant's mountains;* these chains are divided by a great intersection, where the *Elbe* finds a passage from *Bohemia* into *Saxony.* In my descent from this high ground, I saw, on my right, a tract of country everywhere interspersed with large insulated *pyramids;*

mids; and it was towards this tract that I was now on my way.

756. I descended from these hills, by a very gentle slope, into a vale, in which are situated three large towns; one of these is *Podhorsam,* where I was to change horses. In this slope, there are several inflexions, or small vales, with rivulets flowing in them on grassy beds. The waters of these vales, and even of that of *Podhorsam,* not being sufficient, in common seasons, to supply the wants of the inhabitants, it has been found necessary to retain the rain-waters, by constructing across these vales some dikes, which, though not raised to a great height, produce large reservoirs, because the slope is very gradual. Hence the water is drawn off by small sluices at the bottom of the dikes. Thus it is very clear that these vales cannot have been excavated by the waters which flow in them.

757. At half past 10, I set out from *Podhorsam* for *Saaz,* two miles distant, where I arrived at one. I first, by a gentle slope, ascended a hill with a cultivated summit, but cut down abruptly, on the left of the road, towards a large vale, of which the meadows come up to its foot; the sides of several promontories that advance from this abrupt part have crumbled down; but their *cliffs* are easily distinguishable because of the regularity of the slopes, which are covered with grass. The soil of the top of the hill is full of small masses of *white quartz*

and *granulated quartz;* but I saw no *blocks,* till I came to a village at the bottom of a slope, where a number had been collected for the purpose of making stone enclosures. The summit of the following eminence afforded me a nearer view of the region of the *pyramids,* which had a most singular appearance, as it resembled a camp composed of tents of a gigantic size. They occupy a very wide tract of ground, extending one behind another, to a great distance; and in the midst of them rises a mountain, which itself has pyramids along its summit, and of which the sides descend to the common base of the other pyramids.

758. As I crossed a slight inflexion of the cultivated slope, I saw the road bordered for a considerable way with *blocks* which had been detached by gunpowder from larger masses, undoubtedly for the purpose of clearing the fields: some of these were of a *grey granite* with small crystals, others of a *pseudo-granite* formed by the adhesion of small masses of *quartz,* and others of *granulated quartz.* I descended towards the next vale by a hollow road, which, serving also as a channel for the rain-waters that fall on the adjacent slopes, has its sides abruptly cut; and I saw some very large *blocks* projecting in these sides, and some scattered on the bottom; whence it is evident that the loose soil here contains these masses to a great depth. In the extremity of this hill there are two *combes;* and on the lower part of the slope of that on the right, the

small town of *Saaz* is situated. Before I arrived there, I saw that on the skirts of the town there were meadows with large plantations; and beyond these I remarked seme *cliffs*, which I concluded must have a river flowing at their foot.

759. At half past one, I set out from *Saaz*, wishing to proceed three miles further to *Brix*, where accordingly I arrived in the evening. On quitting *Saaz*, I found the *Eger* flowing in the vale by the same *cliffs* which I had seen from a distance: these cliffs are attacked, not by the river, but by the rain-waters falling on the loose soil of the brow of the hill, where they make many deep furrows, and wash down the earth to the borders of the stream, which carries it away during floods, and thus prevents it from accumulating; so that, before any slopes can be formed here, and bound by vegetation, the base of the hill must, by this demolition, be made to retire farther back. In several places, I saw regular *stony strata* in these *cliffs*; and when, having crossed the river, I ascended the hill by a *combe*, which is very wide in its lower part, but narrower towards the top, I again met with the same *strata* in the sides of the combe, where I saw them inclining inwards; whence it appears, that, at the time when the *valley* was produced by a *subsidence*, the *strata* on this side assumed an *inclination* opposite to it. The upper part of the hill is covered with a great thickness of *white clay*; and under this there is a loose soil of a dif-

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ferent kind, which is about 10 feet thick, as I could judge by some deep clefts, and contains large masses of *granulated quartz* and of *basalt*. The river finds a passage towards the right; and I followed its direction for some time travelling over the heights.

760. After I had proceeded a certain way, I descended into a large vale, which contained a village surrounded with meadows, and in which there flowed only a brook in its way to join the *Eger*; yet its opposite side was abrupt, and was everywhere deeply channelled by the rain-waters collected into rills on its surface. Having crossed this and two similar vales, with villages and meadows at their bottom, and watered only by brooks, I entered another, along which the road passes. As I approached the region of the *cones* or *pyramids*, I saw the nearest of them change their form, as I passed before their line at a higher or lower level, according to the inflexions of the road. . From the higher parts, I looked down on the base of these eminences, some of which, at first though they had appeared of considerable breadth, were reduced, as I advanced, into simple cones; while some, which I had taken for single pyramids, were multiplied into several distinct ones, ranged on the same line, one behind another. In short, there were very few of the eminences near the road, which, as I proceeded, did not undergo some apparent change; but, as I passed over too small a space to produce

any considerable difference in the angle formed by my eye with the more distant eminences, I saw, in their figure no perceptible alteration; and few of them assumed any other appearance than that of large pyramids. The loose soil of the hills over which I was travelling was composed of rubbish of *schistus* or of *gneiss;* along the road, I saw some great *blocks* of *granulated quartz,* but more frequently large basaltic *balls* or *prisms.*

761. When I came to the extremity of these hills, I saw before me a vast valley, or rather a plain. I had nearly passed the region of the *cones,* though I still saw several of them at no great distance on my right, and one on my left, which had on its summit an ancient castle, and at its foot the small town of *Brix,* where I meant to pass the night. I should, indeed, have spent the following day there, for the purpose of observing the *cones* in the neighbourhood, had it not been for my fall on the *Ochsenkopf,* in consequence of which, my knee was still in such a state as not to admit of my making long excursions on foot. But luckily M. Von Lilienaw had favoured me with a letter of recommendation to Dr. Reuss, who resided at *Bilin* not far out of my road to *Topliz;* I therefore determined to go thither the next morning in order to call on him; being very certain, from what M. Lilienaw had told me, that, if I had the good fortune to meet with him, he would supply the deficiency of my own observations by the most accurate details.

Sept. 24th.—I set out from *Brix*, at half past 7 in the morning, for *Bilin*, which was at the distance of 3 miles. In the road, I went up a kind of of *combe*, well worthy to be particularly described; as affording a remarkable example of that *gradual* effect of *running waters*, of which the *continuance* is observable, and which, in many places, is not yet *terminated*, though in what manner it will *end* may evidently be seen.

762. This *combe* serves as a channel for the rain-waters, and those of the springs within a great extent of ground: so that, when the former are abundant, they still attack its sides, which they have reduced into cliffs, because the exterior mass of the hill consists entirely of *loose strata*. A small permanent rivulet being produced by the springs, the bottom of the *combe* is covered very thickly with grass; but this bottom, having undergone, during the subsidence from which the *combe* resulted, several fractures across its breadth, whereby successive *steps*, or small terraces, have been formed in it, the rivulet falls in a cascade at the extremity of each of these; and as they are composed of *loose strata*, it wears away their edges when it is full of water, so that they are gradually carried backward the whole way up the *combe*, each of them being shortened below, in proportion as it gains in extent above. At the time when I passed up the *combe*, this process was very clearly shewn by the effects of the late rains, the water of which had not yet all run off. The

cascades were still turbid with the earth detached from each of these small sections of the *loose strata;* but this earth was soon deposited on the grass of the terrace below. Now the progress of this operation was particularly indicated by the nature of the herbage; that of the higher part of each terrace, being raised by the earth which had been washed down on it, consisted solely of gramineous plants, and was therefore of a uniform tint; but annual plants still prevailing on the lower part, the verdure there was of different shades. Earth falls on these terraces also from the sides of the *combe,* which are still crumbling down; and this, in time, will change its bottom into a regular slope, where no appearance of the steps will remain. This crumbling of the sides has already taken place throughout almost the whole extent of the combe, which is sufficiently widened in the upper part, to have permitted them to be there reduced into slopes, and covered with grass. From the highest of these retreating *steps* I entered a vale in the upper part of the hills; the bottom of this vâle is covered with meadows, and its sides, rising in a gentle slope, are cultivated. The vale therefore, since its entrance is the point from which the cascades begin, will supply the earth requisite to reduce both itself and the *combe* into an uniform slope. Thus we find here, under a new aspect, an example of those operations of waters on slopes, which present us with *chronometers* so infinitely varied. At every height we see some operations of this kind, requiring *time* to be brought to a certain determinate *completion;* in many places, they are already *completed;* and this would be everywhere the case, if our continents were of very high *antiquity.*

763. As I proceeded towards *Bilin,* I saw some cones to the right; and on the ground were large basalts, occasionally intermixed with *blocks* of *granulated quartz.* From the higher part of the slope above *Bilin,* I saw that small town, which is built around a *cone* rising from the bottom of a large valley, at the entrance of a very deep defile, whence issues the small river *Biela.* This slope, the whole way down to *Bilin,* is scattered with large *basaltic prisms* and *balls,* on a soil composed of their rubbish; however I still found here some *blocks* of *granulated quartz,* and some others of a fine *granite* with crystals of *red feld-spar.*

764. Dr. Reuss was fortunately at home, and I experienced very great kindness from him. This gentleman has published a Lithology of the *Circle of Leutmeriz,* which is the country of the pyramidal eminences: I could not therefore have been referred to a person more capable of informing me of every particular relating to them. From him I learnt that these *cones,* which, when viewed from a distance, are so similar in their *form,* are yet very different in their nature; that many are *basaltic;* but that great numbers of them consist of other kinds of stones, and amongst the rest of a *porphyric schistus,* (the *porphyre schiefer* of Werner,) the substance of

which is *gneiss*, and the laminæ contain, like porphyry, an abundance of small crystals of *feld-spar*. This region of cones, as I saw from the heights above *Bilin*, commences at *Brix*, and extends as far as the *Elbe*, being chiefly confined between the course of the *Biela*, (otherwise called *Tiba*,) which falls into that river at *Aussig*, and the corresponding part of the *Eger*, which unites with it near *Leutmeriz*. As I was told by Dr. Reuss, the principal cones composed of *schistus* are, first, beginning from *Brix*, the *Breetz-berg*, at the foot of which that town is built, and then three others that I had passed in coming from thence, the *Spitz-berg*, the *Schladnig-berg*, and the *Selniz;* I was now at the foot of the *Biliner-stein*, or Rock of *Bilin*, which is also of this class; and farther on towards the *Elbe* are the *Kostomblot*, the *Gros Franz*, the *Millitschauer-berg*, the *Kletschen*, and some others at a greater distance. There are differences in the *basaltic* cones which are intermixed with these, as the *basalts* of some being in *prisms*, while those of others are in *balls* or *tabulæ*. Dr. Reuss shewed me some *basaltic prisms* brought from *Buchaw*, through which place I had passed; on breaking them, they were found to contain *balls* about the size of a walnut; when the prisms are decomposed by the air, the *balls* remain scattered on the ground. The large *basaltic balls* are like those which I have elsewhere described; in the coure of their decomposition, they split into concentric *strata*, and these *strata* themselves separate into *grains*.

765. Dr. Reuss was so good as to go with me to view the *Biliner-stein*, the description of which may convey a sufficient idea of this class of eminences. This rock, rising from the soil of a vale, and consisting of a group of pyramids, resembles, on a small scale, the *Aiguilles* in the valley of *Chamouny* near *Mont Blanc*, and has been produced in a similar manner: it is composed of pyramidal laminæ of the *porphyric schistus*, which, having undergone, during their catastrophe, an angular motion attended with a shock, were thus split into separate masses of *strata*, now become nearly vertical. We have here, as well as in the *Aiguilles de Chamouny*, an example of the various actions, which, since the retreat of the sea from our continents, have been exercised on them, according to the situation of their parts, by exterior causes. This cone, on one side, terminates on the brink of a deep *cleft*, at the bottom of which the *Biela* flows. Now on this side its base is continuing to wear away, from the effects of the rains, the frosts, and other actions of the air; and the progress of the demolition is even very rapid, because whatever fragments fall down into the cleft are carried away by the river: upon the slope here, therefore, there were only a few straggling blades of grass; for during great rains, the whole surface sometimes slides, from top to bottom, into the cleft. But the case is very different in the other parts of the rock, the several masses of which, forming different ridges with intervals between them, are worn away, in the same manner, on their sides; but the

rubbish detached from them, being detained at their foot, rises against them in slopes, and tends to fill up their intervals, in which this new soil already ascends to a great height, and is covered with plants and bushes. To this cause, as I have said before, is to be attributed the regularity of many of the pyramids which I have elsewhere described, and which were originally studded with rocks, though only the summits of these rocks at present appear, the intervals being filled up with rubbish.

766. We then descended to the edge of the deep *cleft*, where Dr. Reuss made me remark that only *gneiss* was to be seen on either side, but with its *strata* in different situations; in the *Biliner-stein* they *incline* inwards, descending beneath the mount; while on the opposite side of the cleft, though at so small a distance, they present their plane towards the lower part of the valley. It is therefore evident that, though there has been here only a simple *fracture* of the *strata*, this fracture, which, to a certain height, is filled up with rubbish, must have extended to a sufficient depth to permit the masses on its opposite sides to undergo very different *angular movements;* in consequence of which it has been widened above, and a passage has thus been opened for the *Biela*, arriving hither through meadows, where it holds a winding course. During this catastrophe, in which all the strata were involved, those of *porphyric schistus* were precipitated into the sunken space, leaving the *gneiss* uncovered; as I have shewn to

have been the case with the *granite* in the mountains of *Fichtelberg*, and as, in other places, the *strata* of *lime-stone*, by similar catastrophes, have been deprived of their covering of *sand-stone*. In the intervals of the pyramidal mounts, whether *schistose* or *basaltic*, the whole ground, to a great distance from this region, is covered with *basalts* of different kinds; and it is in a mixed *sand* of *schistose* and *basaltic* rubbish that the *garnets* are found which form an article of commerce, under the name of Bohemian garnets; yet no basalt, nor any kind of stone that appears externally, is known to contain them; so that their origin has not yet been discovered, though they are met with in great abundance in the superficial soil.

767. After having received all this information from Dr. Reuss, and made these observations in his company, I set out from *Bilin* for *Töpliz*, where I arrived at 4 o'clock. I first crossed the large valley or plain of which I have spoken, and then proceeded along the foot of the *Ertz-gebürge*. In this valley, there are beds of *coal*, under strata of *sand-stone*; *strata* of *stone-marl* are also found here, and are used for making *lime*. According to the information which I obtained, *coal* is met with in other vales between this and *Egra*; and as, in some places, it is seen to pass under the *gneiss*, it is supposed by some to have been originally thus situated. But I have already shewn it to be beyond a doubt that beds of *coal* proceed from *peat-mosses*, which were

formed on *islands* in the ancient sea; and that, these islands having afterwards sunk beneath the level of the waters, the peat was there covered with strata of sand and marl, frequently containing *marine bodies*, and certainly posterior to the *strata* of *gneiss*. After the *peat* had been mineralized into *coal*, and covered with *stony strata*, the whole bottom of the sea underwent the most violent catastrophes; so that the beds of *coal* have experienced as great *fractures*, *angular motions*, and *dislocations*, as any kind of stony stratum: it is not surprizing, therefore, if *strata* of *gneiss* have in some places slidden over these beds.

768. When I had advanced a certain way towards the chain of the *Ertz-gebürge*, I followed its direction, nearly at the same distance, keeping it on my left till I reached *Töpliz*. I had learnt from Dr. Reuss, that, though the mass of this chain consists of *gneiss* from top to bottom, there are on it some *basaltic* summits, similar to those found in lower situations. Now, as I have already said, this chain is the contination of that of the *Tichtelberg*, in which, while there are also *basaltic* eminences, the highest summits are of *granite*, the *gneiss*, together with the *schisti*, forming only lower ridges bordering the granitic. Little doubt, therefore, can be entertained that, in the *Ertz-gebürge*, the *gneiss* has remained upon the *granite*, and that the latter extends under all the lower country consisting of hills and plains; this is evident also from the granitic *blocks* which are

scattered on the hill, and from the rocks appearing here and there, as, for example, in the hills at *Carlsbad.* The lower mass at the foot of the chain, has not, on this side, subsided uniformly; the subsidence has here taken place in such a manner as to produce several successive terraces, the front of each of which was originally abrupt; but its rubbish being retained on the terrace below, and there rising in a slope, the whole of this side of the chain is either clothed with woods, or covered with turf; and its base, having been much extended by the rubbish which the waters washed down before the surface was bound by vegetation, is at present cultivated.

769. On turning towards *Töpliz,* I ascended a soil higher than that over which I had hitherto been travelling, and for a little way, I found on it large *blocks* of reddish *granulated quartz.* Farther on, I saw a great many *basaltic balls* along the sides of the fields, and there was a rising ground to the right, on which I judged that they likewise abounded; but it could not have been the source of those near the road, because the difference of level was very inconsiderable, and at the foot of this little eminence, there was a great extent of horizontal ground, with *basaltic balls* scattered over the whole of it. Probably, therefore, the soil of the fields, which is now lower than that at the foot of the mountains, had been covered with *basalts* before it subsided to its present level. Immediately above *Töpliz,* the

road is cut through the foot of a hill of reddish *porphyry;* and as I descended this hill, I saw another similar to it on the opposite side of the town.

770. *Töpliz* is a place which is much frequented on account of its baths; and there, as I had previously expected, I had the pleasure of meeting with my worthy friend, Baron Von Reck, Chamberlain to the King of *Prussia,* who knew the objects of my journey, and was so good as to furnish me with a guide to view the neighbouring country. I set out between 4 and 5; and having reached the borders of the hill on the side of the town opposite to that on which I had entered it, I saw there a deep cleft, similar to the defile at *Bilin,* and exhibiting *strata* of the reddish *porphyry* on both its sides. On observing the spot, it may evidently be seen that this cleft cannot have been made by a brook now flowing at its bottom; for the hill rises in a gentle slope towards the higher part of the course of this little stream; which, if it had not met with this long cleft, would have formed a small lake above, whence it would have poured its waters into a combe leading down on the left to *Töpliz.* I then ascended the opposite hill, by which I had entered the town, where the soil consists of a sand produced by the decomposition of the *porphyry,* mixed with fragments and even *blocks* of the same stone, of which I saw rocks here and there on the slope, all the way up to the summit. This decomposition of *porphyry* is still continuing, and has in part taken place on the surface, since the continent has been abandoned by the

sea; more ancient catastrophes, prior to the birth of the continents, had however prepared the way for the operation; for not only do we find these *strata* of *porphyry* completely in ruins, but, among the *blocks* of this stone which lay on the slope, I saw some very large ones of *granulated quartz*. I had the pleasure of spending the evening with the Baron, and we then parted, to meet again at *Berlin*.

Sept. 25*th.*—I set out from *Töpliz*, at 7 in the morning, for *Aussig*, 2 miles distant, where I arrived at half past 10. On leaving the former place, I travelled for some time over the same hills of *porphyry*; but long after its *strata* had disappeared from the surface, I continued to see large *blocks* of it, at first alone, then mingled with *blocks* of *granulated quartz*, and at last with *basalts*. The road was very much up and down hill; in one of its inflexions, all these stones disappeared, and I proceeded a considerable way without seeing any; but afterwards I again observed the *basalts*, which continued to prevail alone till I came to *Aussig*.

771. From the top of the last eminence, I saw this small town, situated at the junction of two vallies. I descended into one of these vallies by a gentle slope, and crossed it in a part where it was very wide; its horizontal bottom extends to a ridge of opposite mountains, which are steep, and much intersected; but all their fronts, originally abrupt, have slopes of their own rubbish formed at their

foot, and now clothed with vegetation. On the right, the *Biela* enters this space, which was levelled by its waters, and those of the brooks uniting with it, during their earlier inundations; the soil of this valley is very rich; and it is cultivated down to some meadows which border the river, and which are still sometimes under water. I had here a distant view of a large cleft in the above ridge of mountains; and when I reached *Aussig*, I perceived that the *Elbe* finds a passage through this opening, and, on issuing forth, suddenly, bends its course to follow another valley, taking a direction almost at right angles with that which it had held above. This river is joined by the *Biela* a little below the town.

772. On my arrival at *Aussig*, I went to call on M. FR. KÖHLER, to whom I had a recommendation from his brother at *Egra;* I informed him of my plan to engage here a covered boat of sufficient size to contain my chaise, in which I might go down the *Elbe* as far as *Pirna;* he tried accordingly to procure me one, but all the boats belonging to this place happened at present to be out. It was 11 o'clock, when I received this information; and in order to employ the time till the return of the boats, I went to examine the entrance of the valley into which, as I have just said, the *Elbe* turns its course.

773. Here a large promontory which is called *Marienberg* advances below *Aussig* on the left bank

of the river; on the side next the town, its slope is covered with rubbish and planted with vines. This promontory is cut down abruptly towards the river; but that the latter has not here opened the passage for itself, may easily be judged; for, on crossing the promontory, I found that its slope on the opposite side descended to a large tract of low ground which was perfectly open; so that, unless the river, when it began to flow, had found a deeper channel ready for its reception, it would have spread over this tract, and have taken its course, in a quite different direction, along other vallies on a level with this soil.

774. This promontory of *Marienberg*, which branches off from the top of the hills on the left bank, is prolonged to a considerable extent on the other side of the river; the passage for the stream has here been opened by some catastrophe which has broken through the promontory; for both sides present the section of their *strata*, though the section on the right bank does not rise to nearly so great a height as that on the left. Having crossed the river, I ascended the right bank. The *strata* on both sides are of *porphyric schistus* of a bluish grey; but I should have been unable to distinguish them in the high section of the left bank, here opposite to me, unless I had recollected one of M. de Saussure's rules, which I consider as very correct. In this section I could only see that some *lines* almost *horizontal* were intersected by others nearly *vertical*,

and that those of each class were parallel with each other. But M. de Saussure has remarked, that such masses as these cannot naturally be supposed to have *split* in a *horizontal* direction, because the heaving of the higher parts, which alone could produce this effect, is prevented by their weight; whereas an equal subsidence of the parts may easily have occasioned them to split *vertically;* so that the *lines* nearly *horizontal* may, in such a case, be considered as the *separations* of the *strata*, and those which are *vertical* as *fractures*. According to this indication, these *schistose strata* are *inclined*, but in different degrees, in consequence of the changes produced by the different degrees of *subsidence*.

775. Proceeding along the lower part of the promontory, which is beyond the point where the *Elbe*, after having bent its course, enters the cleft that divides this projection, I descended into the valley by which the river arrives at *Aussig*, and followed it up to the part where, on issuing from the *Giant's mountains*, it makes a turn in order to enter this valley; the walk took me up about an hour. At the opening of the valley, (and above *Aussig*,) on the left bank of the river, there rises a steep side, the lower part of which is entirely covered with *basaltic balls*, *tabulæ*, and *prisms*, some of the latter being very large; while the opposite bank, for a considerable way, continues very low, and is all in tillage, without *blocks* of any kind. Higher up on the left bank there is a large insulated rock,

which appeared to me to consist of *schistus*, and on which stands the ancient castle of *Schrekenstein.* As I continued to ascend this bank, I came to a very singular *basaltic* phenomenon. This is a promontory, about 100 feet high at its extremity, where it is cut down abruptly towards the river, from which, however, it is at too great a distance to be reached by the water. On considering the form and the position of this promontory, I perceived it very plainly to be composed of a *basaltic* lava different from all which I had passed before. The basalts are very distinct, both in its steep face and in its sides. This steep face is in the form of a banana leaf, with its end downwards; a large rib runs along its middle, diminishing in size from the top; smaller ribs branch off from this on both sides, turning in, at the bottom, towards the principal one; and at the point where the latter terminates, the small ribs bend round its extremity in the form of a kind of fan. These lateral ribs are formed by very small basalts; and it may be judged that, in whatever part of its length this promontory should be cut across, it would exhibit the same figure which I have above described; for the extremities of these *basalts* are everywhere seen on its sides, being arranged like logs in a pile of wood. I have mentioned a similar phenomenon on the borders of the *Rhine*, in the country of *Bonn*, where it extends over the bed of the river: now that is a region in which I have described many true *volcanic cones*, with their *craters* composed of *scoriæ*, and their *porous lavas*, all the lands around being covered with *volcanic ashes*, and *pumice-stone*. But here I saw none of these decidedly *volcanic* indications.

776. I continued to ascend this valley, till I reached its upper extremity, where the river bends to enter it. When I came to the opening of the higher valley through which the *Elbe* arrives at this point, I saw, at its farther end, very lofty mountains, belonging to a ridge that borders the right bank of the river above; the summits of this ridge, within a certain extent, rise to a greater height than those of the eminences on the left bank. On these mountains I observed a *chronometrical* phenomenon of a kind already described in the *Ertz-gebürge;* and indeed it is one which may be seen in all great mountains: their front abrupt and much intersected, is almost entirely covered with fir woods or with grass; because the gradual subsidence of the *strata* before them has left in their slope terraces, on which the *rubbish* of the higher parts has accumulated in successive *taluses*. But as, in some parts, none of these *terraces* have happened to be formed, the *taluses* there, though rising to a great height, extend much lower down, and are still bare, because fresh rubbish is perpetually falling on them from the rocks above; which will continue to be the case, until, in consequence of the gradual lowering of the rocks, and the progressive elevation of the taluses, these falls of rubbish shall no longer take place. I must here repeat what I have said with respect to other

chronometers of this class: it is fortunate for future generations, that, in our age, exact geological observations have at last been made, and that the different classes of phenomena presented by the surface of the earth have been clearly stated; for a great number of these are by degrees obliterated; (a circumstance, indeed, which is itself a kind of *chronometer*;) and when we shall have entirely lost sight of them, no physical means of tracing back past events will remain, except by digging to a great depth, in various places, through vast heaps of fragments, in order to discover what lies beneath them.

777. This same part of the course of the river affords an example also of what will be the ultimate state of the borders of all rivers, sooner or later, according to the nature of their original beds. While I stood by the bend of the *Elbe*, I had a view of its course both above and below that point; the air was perfectly calm; and, as far as I could see, the surface of the stream, as smooth as a mirror, reflected, with the greatest clearness, the objects on the opposite bank: though the water was at this time shallow, there was nothing which could ruffle it, either on its borders or its bottom. In the upper part of this space, I do not believe that the most exact level could have indicated any slope. From *Schrekenstein* down to *Aussig*, the bed of the river is less horizontal; and there its surface was so much ruffled by the stones on the bottom, that the smallest boat would at that time have found some difficulty in passing.

778. In the part above the bend, the declivity being so small, the sand brought down during inundations has mostly been deposited on the bottom, where it has buried the stones which originally were there; the stream, therefore, has not *brought down* those that lie on the lower part of its bed, but has merely prevented the sand from accumulating in so great a quantity between them. There is no river on the course of which some similar part may not be found; whence it is manifest that rivers do not really carry along with them any thing but sand; *torrents* only, when descending rapidly from the mountains in narrow channels, have sufficient force to move the stones on their bed; and the idea that *vallies* have been excavated by *running waters* could neither have been conceived, nor have obtained credit with so many persons, unless these phenomena, which are observable in all parts of the continents, had been viewed in a very careless and superficial manner. I have said, and I do not fear to repeat, that this idea has diffused obscurity over the whole science of geology: I have therefore here recurred to the subject, for the purpose of fixing the attention of my readers on all the circumstances which I shall continue to describe along the course of the *Elbe*.

779. On my return to *Aussig* at 2 o'clock, M. Köhler informed me that there was no likelihood of the return of the boats this evening, and that it was even uncertain whether any would arrive on the

morrow; he advised me, therefore, to go by land to *Tetschen*, which was a port more frequented, 3 miles lower on the river. I thought it best to adopt this plan; and M. Köhler having been so obliging as to wait dinner for me, I sat down to table with him while the horses were getting ready; after which I set out at 3 o'clock.

780. A great part of the road from *Aussig* to *Tetschen* is very bad; but for this it compensates by presenting a variety of beautiful prospects, together with many interesting objects of study relating to the history of the earth. I first proceeded along the left bank of the *Elbe*, passing under the abrupt promontory of *Marienberg*, the whole base of which is strewn with blocks of its own *porphyric schistus*. After I had passed through the defile formed by the intersection of this promontory, I entered the low space which opens beyond it by the retreat of the hills, especially those on the left. The river, in its first inundations, occupied the whole of this space, spreading over it all the large materials which the torrents brought down from the mountains, and which, having propelled them through the defile, where its rapidity is the greatest, it finally deposited in this basin; it is, however, very evident here that, for a long time, the sediments of the stream have not consisted of any thing more than *sand*. The road is carried along the part where the soil, having been at last raised above the level of common inundations, is now in tillage; but over some

spaces, which were probably lower than the rest at first, and are not yet completely filled up,—the road is continued by a causeway composed of *basalts*.

781. The mountains afterwards advance nearer to each other; and as I travelled along the left bank of the river, I came to a projection consisting of the same small *basalts* which I had seen in the rock above, and which here also were arranged in a regular form, though not the same as in that rock. For a certain way, the mountains on the opposite sides of the river alternately approach each other and recede; their slopes are, for the most part, clothed with verdure, but in those parts in which they still continue to crumble down, the *taluses* of their *rubbish* are not yet bound by vegetation. I crossed the river at a point where it was of great width, and consequently not very rapid. I then proceeded along the right bank, on which the ground, sloping very gradually down to the level of the water, exhibits the most beautiful rural scenery; being chiefly laid out in orchards of fine fruits, which were at present ripe. The river is immediately bordered with meadows; but it is not by the stream that the soils above the reach of its inundations have been levelled, for they were originally low, and I saw along the sides of the fields and orchards a quantity of *blocks* of different species, which had been taken out of them when they were cleared for cultivation.

782. The whole way from *Aussig* to *Tetschen*,

the valley of the *Elbe* bears marks of its formation by a great *subsidence* of the *strata,* which here have totally *sunk;* and not the principal valley only has been thus produced, but likewise a multitude of smaller ones that branch from it: the angular movements undergone by the masses left at the highest level have converted those masses into ridges of mountains with angular summits, which present to the *Elbe* sections of a *pyramidal* form: many of them even, being cut off behind, rise as insulated *pyramids* by the river side; but there are great differences in this respect, and I have observed some remarkable changes in the appearnce of these mountains, as I changed my relative position towards them. While I was travelling along the right bank, an eminence on the opposite bank for some way presented itself to my view as a *pyramid;* but, after I had passed it, I saw that it extended behind to a great distance; and its appearance led me to judge that it was of *schistus,* like those above it. The following example will exhibit greater variety.

783. I entered a plain encompassed with mountains in a manner extremely picturesque; and as the road passed along the foot of those which were farthest from the *Elbe,* that river was for a long time concealed from me by those on its borders. Here then I beheld nothing but a large circle of mountains, terminated in front by one of superior height, which had the appearance of a single pyramid cultivated almost to the top, with some spaces

on it covered with grass, and others with wood. But as I drew nearer to it, with a small change in my point of view, I saw its summit separate into a number of distinct pyramids, by the most forward of which I was afterwards again deprived of the sight of those that stood behind it; while at the same time I discovered in its front some lower ones, which before had appeared to form a part of the principal mass. When I came up to this eminence, I recovered sight of the *Elbe* through an opening on the left; the right bank of the river, along which the road continues to pass, being formed by these pyramids. On this side, their mass is broken into several promontories; and it is very remarkable that the first is of *basalt*, while those which follow it are of a grey *quartzeous schistus*, very hard, and exhibiting, when broken, a shining surface. The last promontory rises to a great height, and is entirely precipitous on the side next the *Elbe*, so that it has been necessary to cut into its foot to make the road; whereas the left side of the river presents only a low terrace extending to some distant mountains, which are covered with wood.

784. All these eminences equally shew the nature of the catastrophe whence they originally resulted, in which, the general mass of the *strata* having been divided by fractures, the separated parts underwent *angular movements*, in consequence of the greater *subsidence* of one of their sides; while at the same time vast masses totally sunk and disappeared, the

space which they had originally occupied remaining vacant down to a certain level. It is thus that all these *vallies* have been produced, even the deepest one which affords a passage to the *Elbe.* Most of the ridges of hills formed by these movements have angular summits, and many parts of them have been dissected, by transversal fractures into *pyramids*, assuming different appearances in consequence of the original differences in their forms. In some of them, the *strata*, being nearly *vertical*, have separated during their fall, and have thus produced clusters of *pyramids*, of which the highest are situated towards the centre of the groups, and the lower ones around them. Of these pyramids, such as have their sides too rapid to allow the falling rubbish to rest on them, continue in great part naked; but others, having on their surface many sharp projections which have retained this rubbish all around, have taken the form of *cones*, with only a few rocks rising above the rubbish, and shewing the disordered state of the masses within. In general, the slopes of these cones are clothed with verdure; but the plants on them differ according to the nature of the rocks: where the latter are foliated, and the rubbish which composes the taluses is consequently very minute, these slopes are grassy; but they are covered with woods where the strata, being more compact, have fallen in large masses, as divided by fractures. The bases of these eminences, which are of great extent, are for the most part cultivated, and the higher parts of the slopes are planted with vines, on the side where the aspect is favourable.

785. No country can present a more cheerful appearance than this part of the borders of the *Elbe*, where the terraces which project from the foot of the mountains, and are in some places of great breadth on account of the distance of the latter, are all laid out in orchards of the finest fruits, which yield a considerable revenue to the proprietors of the land, being carried down the *Elbe* to *Hamburg*, and brought to *Berlin* up the *Spree*. This was the season for those excellent plumbs, which are dried to be sent to a distance, and which are made into what is called plumb-cheese, over all the north of *Germany*. At *Aussig*, where this kind of commerce begins, I saw boats filled with baskets of these plumbs, and the trees were loaded with them in such extraordinary abundance, that great quantities fell into my chaise, whenever it happened to strike against the branches as it passed along. Many other boats were laden with baskets of pears and apples of the best kinds: among the former were white and brown *beurrées*, which are carried from hence to *Berlin*; and among the latter were *burschäpffel*, a very excellent fruit, much esteemed in *Germany*, and sent as far as *Petersburg*, packed in chests, each apple being folded in a separate paper. All these valuable kinds of fruit are gathered with much care, lest they should be bruised; and as I travelled on, I saw, in

all the trees, women and children, who were plucking them from the branches, and laying them softly in baskets, which they let down by cords with hooks, while others stood under the trees to receive them.

786. In this road along the right bank of the river, here still bordered with high mountains, I crossed the beds of several torrents issuing from deep clefts in these mountains, the sides of which had not yet ceased to crumble down. I judged that, during seasons of great rains, or the melting of the snows, these torrents must be very considerable; for, where they intersected the cultivated terraces, I found their beds raised above the rest of the soil by the quantity of stones which at such times they had propelled along their course. The same precaution is used here as in the great vallies of the *Alps*; and I have described it also in the *Giant's mountains*; this consists in keeping open a channel for the torrents along the highest parts of the ridge of rubbish which they have brought down from above, in order to prevent them from spreading over the neighbouring lands, and scattering the stones, instead of thus merely propelling the latter a little farther. I saw on these beds stones of different kinds, chiefly schisti; but they were mingled with basalts, of which, consequently, there must be some in the mountains, though, in general, these eminences consist of schistus, as far as *Tetschen*, where I arrived in the evening, and took up my lodging for the night.

Sept. 26th.—I had here a recommendation from M. Köhler of *Aussig* to M. Richler, who gave orders that a covered boat should be hired for me, and my chaise placed in it; after which he walked with me to view the environs of the town, and particularly the castle, where thence is an extensive prospect of the wide terraces that border the *Elbe* from the foot of the mountains.

786. *a.* I have said that the schisti extend as far as *Tetschen;* but here they cease, and at this place begins, on both sides of the *Elbe,* that beautiful white *sand-stone* which, in my last journey, I described opposite to *Pirna.* I then mentioned that the *strata* of this stone contain *sea-shells,* particularly large *pectines;* and I found some *tubes* of *sea-worms* in those of the hill on which the castle stands. These strata must therefore have been formed upon the bottom of the sea, in a situation nearly *horizontal,* and certainly over the *schisti;* yet here, both these different kinds are on the same level, and at the point where those of sand-stone externally commence, they are found leaning against the others. Every thing bears impressions of the catastrophes from which resulted this subversion of the *strata,* and in this place, a phenomenon similar to that described at *Aussig* has been one of their effects; the *Elbe* passes through an intersection of a ridge of *sand-stone* descending from the hills on the left bank; and, on the separated extremity of this ridge, forming part of the right bank, stands the castle, which

is very large and in good preservation, and which, at this time, was undergoing repair: but I have to describe still farther phenomena, capable of removing all doubt that the river found this channel open at the time when it began to flow. The summit of this detached extremity of the hill, which is occupied by the castle, is cut down abruptly towards the *Elbe*, as well as on both its flanks; but in the part farthest from the river it descends gradually to the level of the town, having on each side a large open space. Hence it is very evident, on viewing the spot, that, if a deeper channel had not been originally cut on the left side of the rock, the *Elbe* would have taken its course on the right side; which it might have done without making a very wide bend.

787. From the castle-hill, I saw, on the left bank of the *Elbe*, three promontories, which are composed of the same *strata* of *sand-stone*, and which, advancing towards the river, are cut off on its brink, where they have the appearance of *pyramids*, rising nearly to the same height, and being all equally abrupt: the first of these, that is to say, the highest on the course of the river, is the promontory already described, upon the continuation of which, on the right bank, the castle stands; opposite to the other two, this bank presents only an open space. Now the situation of the *strata*, here seen very distinctly, proves that these eminences are masses left at a higher level than the rest during the *subsi-*

dence which produced the *valley* of the *Elbe;* and that, while *sinking* themselves, though in a less degree, they underwent various *angular movements*. In the promontory corresponding with the castle-hill, the *strata* are nearly *vertical;* while, in the sections of the two following ones, which terminate at the river, without any continuation on the opposite side, the *lines* of separation of the *strata* in the abrupt extremity are nearly *horizontal*, and on the sides their *planes* may be seen to incline backwards. These particular descriptions will afford precise examples of the effects of the catastrophes of the *strata*, in *mountains*, and along *vallies;* and they will prove an assistance to persons engaged in similar observations.

788. At half past 9 I embarked at *Tetschen* for *Pirna*, where I arrived at half after 4; I was thus 7 hours on the water, though the distance was only 6 miles; but the current was so slow, that this little voyage would have occupied me twice as long, if I had gone down the stream without the assistance of two rowers. The weather being calm and pleasant, I remained the whole time on the deck of the boat, attentive to the objects which seemed to pass in review before me.

789. Though the course of the river was winding, yet, for some time, its abrupt sides continued to be nearly parallel with each other, while they exhibited all the characters of a double fracture attended by

the subsidence of the intermediary mass, and by different angular motions in the masses which had remained at a higher level. On the sides, some detached masses formed projecting rocks, where, when viewed from the river, the *lines of separation* of the *strata* were nearly *horizontal;* but on observing these masses laterally, in large clefts, I perceived that, in some of them, the strata inclined towards the river, and in others, the contrary way. When the *strata* are in this latter position, their section commonly begins from the top of the abrupt side; but when they incline towards the river, there is, above this section, a woody slope; and, in many places, eminences interspersed with rocks, and covered with firs, are seen to rise behind This is the same *sandstone* which I mentioned in my former journey, as a kind greatly esteemed for building; accordingly it is carried down the *Elbe*, and transported to a greater distance; when broken, it exhibits a shining grain, and the sand detached from it by decomposition is of a nature quite different from that of the *sandstone* of the country of *Bayreuth;* for, as I have already remarked, the latter produces only *pines*, while the sand of which I am now speaking produces *firs*, like the rubbish of the *schisti* and the *basalts*.

790. There were many parts in which I saw two ridges of eminences, one on the bank of the river, the other higher, and at a greater distance. In some places, the anterior part of the ridge that borders

the *Elbe*, having subsided the most, has left some elevated rocks, which, by crumbling down, have formed slopes of rubbish, either terminating at the top of some projection whereon they rest, or extending from above quite down to the borders of the river: most of these slopes are covered with grass; but in other places, where large *blocks* have fallen on the declivity, it is covered with firs interspersed among rocks of a columnar appearance, as I described in the preceding journey.

791. These mountains bordering the river are intersected by several *valliss* or *combes*, of the sides of which I had a view as I passed before their openings; these sides likewise present abrupt sections of the *strata*, and their upper part is cut into such forms as bear a resemblance to the walls of ancient castles. When two of these intersections happen to be near each other, the masses in their intervals rise into high *pyramids*, surrounded with smaller ones, or with *columns*, which are continued all along the terraces on the border of the river. The *vallies*, being deep, and extending to some distance inland, bring to the *Elbe* streams of a considerable size, one of which turns a mill at *Niedergrund;* this is the last hamlet belonging to *Bohemia* on the left bank of the river, and it consists in part of a long row of houses encompassed with gardens and orchards; on a broad terrace at the foot of the steep face of the mountains. Lower down on the river, the rocks, having happened to

be much shattered, were still crumbling down in very large masses, which overspread a considerable portion of the breadth of the terrace at their foot. When I arrived at this part, it seemed as if the passage of the *Elbe* was here entirely closed; for there rose before me, at some distance, an abrupt mountain, the top of which appeared to be divided into a number of *pyramids;* but, as I approached, I lost sight of these *pyramids* one after another, and what had at first seemed the foot of a large mountain bore now the aspect only of a steep rock. In front of this projection, the river turns to the right; and a little below its bend, there is in the right bank a cleft, the entrance of which is of sufficient size to form a port; and this cleft extends far enough inland, for rafts of wood to be brought down from some distance by a very small stream that flows in it: here is situated *Hornkatschen*, the first custom-house which belongs to *Bohemia* in ascending the *Elbe*. For a certain space, the sides of this cleft are of the same height with those of the river itself, which flows hence towards another great cleft. At this point, the sides suddenly rise; and here I found them crowned with those large *pyramids* which had vanished from my sight when I approached the steep rocks apparently closing the passage of the river when viewed from above.

792. There are very wide terraces along all these shores of the *Elbe*, except in that part, a little below *Niedergrund*, where large masses continue to fall,

and leave but a small space between the foot of the slopes which are formed against the *rocks*, and the river; and though, in other parts, great fragments, from time to time, are still detached from the top of the rocks, these fragments roll down the slopes of rubbish, and stop at their foot. Thus all the terraces are grassy, down to the shore of the river, which being at this time a little swelled by the late rains, the grass extended below the water's edge. Throughout all this part of its course, the *Elbe* is very broad, and flows very slowly; its surface, when I sailed down it, was as smooth as a mirror; and I could judge that, though subject to extraordinary swells, this river was so far, at such seasons, from injuring its grassy banks, that, on the contrary, it was still continuing to raise them by the deposition of fresh sediments. I shall presently mention an extraordinary instance of this as contributing to prove what I have elsewhere affirmed, that rivers no longer attack their shores in any part except where they have not yet opened for themselves a free passage.

793. After the left bank had been lower for some way, I arrived in front of a large space where the rocks on that side are entirely discontinued, and where there are only pasture-grounds extending from the borders of the river to some fir-woods at a considerable distance: but opposite to this open tract, the right bank is bordered with steep rocks, and in these are the first large quarries of the *sand-*

stone that are within view in going down the Elbe; these quarries are continued as far as to a large cleft, of which the sides are no less steep than those of the river; though, as it is only a *combe*, no water passes through it, except in rainy seasons: the bed of the rivulet which is then formed in it was at present dry.

794. Below this point, the right bank changes greatly its appearance: the rocks, which are low, are at a great distance from the river, and their higher parts form slopes covered with trees or with grass, according to the nature of the rubbish whereof they are composed. On a wide terrace in their front is a long row of cottages extending to the small town of *Schandau* within the Saxon territory. The calmness of the river on which I was sailing, and of which the surface continued to be perfectly unruffled, permitted me to enjoy the beauties of the rural scene that here presented itself to my view in one of its happiest moments. Some of the villagers were employed in making their second crop of hay on the terrace, while others were gathering the fruit in the orchards; the pastures were full of cattle; goats were browzing on the rocks; and the good housewives, with their little children around them, were busily employed in brightening their kitchen utensils, and washing the vessels belonging to their dairies. I had great pleasure in the thought that the course of the lives of these happy villagers was

probably as tranquil as that of the stream from which I observed them with so much satisfaction.

795. In approaching an eminence of this right bank, called the *Lilien-stein*, of which I spoke in my former journey, I could easily perceive its summit to be no higher than those of many of the steep rocks that I had seen in coming down the river; but the ground has subsided all around this eminence, and its slopes, covered with large masses detached from the highest part, descend quite down to the low soil. There being on the summit of the *Lilien-stein* an elevation much narrower than the zone immediately below it, which is very wide, it hence assumes various appearances from different points of view: at a distance, it seemed a vast *pyramid*, with a very narrow summit; but as I approached, this summit sunk, as if retiring from me; and though I never lost sight of it, as I turned round the base, it yet appeared to be shifted, like a tent, from one part of the eminence to another. The highest of the rocks around the *Lilien-stein* are extremely picturesque, for they suffer from the air that erosion to which, as I mentioned in my last journey, this *sand-stone* is liable; and their forms likewise continually vary with every change of the spectator's position.

796. A little after I had passed the *Lilien-stein*, I saw rising on the left bank of the *König-stein*,

another *pyramid* which descends with an uninterrupted slope to the village bearing its name, and to the shore of the river; so that its height appeared very great when I viewed it in front: I did not however judge its summit to be really higher than that of the *Lilien-stein;* but it is of great breadth, and is occupied by a fortress, to which the rocks themselves form towers, and walls crowned with battlements. On both sides of the *König-stein* I saw, farther inland, and at different distances from the *Elbe*, many other insulated *pyramids*, all too remote to have been formed either by the river itself, or by any of the small streams arriving here to join it; they must, therefore, have resulted from the catastrophes of the *strata* to which I have attributed the rest of the *pyramids* that I have described along the course of this great river, and in which the whole of the neighbouring country must have been involved.

797. Some way beyond *Königstein*, I came to the part of the course of the *Elbe* described in my former journey; at present, therefore, I shall pass it over, mentioning only the remarkable circumstance to which I alluded § 792, when speaking of the *inundations* of this river. I passed in front of a village on the right bank, called by the boatman *Wilstatel;* but I did not find that name in my map. Part of this village, like some others which I have described before, consists of a long row of houses on the terrace bordering the *Elbe;* these houses are

nearly at equal distances from each other, and the gardens and orchards around them are enclosed with low walls, leaving on the outer side a large grassy space which extends to the river-side. Here the boatman told me that, during the preceding winter, when, as I have already had occasion to say, all the rivers in the north of *Germany* had overflowed in an extraordinary manner, the level of the *Elbe* had risen up to the windows of the upper story of the houses of the village, but fortunately so slowly, that the inhabitants had had time to escape with their effects. Now no traces were remaining of the action of the water on either the fronts of the houses or the garden walls, nor even on the trees or grass of the terraces. The river had gradually risen, extending its surface to a great breadth, but with little rapidity, on its borders, the principal current remaining in the *middle;* and it had afterwards sunk slowly as it retired; so that it had done no damage to any part of this great terrace.

798. As I approached *Pirna*, the rocks on both sides became lower; their fronts are here very smooth, and their projections so regularly angular in consequence of vertical fractures along the edge of the subsidence which has produced the great valley of the *Elbe*, that this river appears as if bordered by fortifications; and the same form is continued on the sides of a large cleft in the right bank. On this bank, the space in front of the rocks is laid out in vineyards extending nearly to the bor-

ders of the river, which is here of great breadth, and flows very slowly.

799. At half past four, I landed at *Pirna;* and I determined to employ the rest of the day in walking down the left side of the *Elbe*, in order to observe the point at which this river, hitherto confined between its elevated banks, issues forth into the plain. After I had passed the castle of *Pirna*, I saw that the promontory whereon it stands is cut down abruptly on the lower side, and that, beyond the intersection, the ridge, to which this eminence belongs, is continued only by a small mount descending gradually to the level of the plain. This promontory is composed of the *strata* of *sand-stone*, and follows the shore of the river. I went on, till I came to the termination of the eminences which had so far formed the left bank of the *Elbe;* while the rocks on the opposite bank also became gradually lower, till at last they passed beneath a soil of rubbish. I thus reached the borders of the plain, on the left side of the river. Hence I saw at a distance, on the right, the chain of *granitic* eminences which, in my preceding journey, I had ascended from *Pilnitz* with M. Köhler; and, on the left, I discovered, above some distant hills, the pyramidal summits of the schistose mountains, among which, in the same journey, I had gone down the course of the river, as far as *Pirna*, with him and Baron Von Block. The interval between these two chains, below the issue of the *Elbe* from its defiles,

was likewise open to view, to as great a distance as the eye could reach.

800. Here then we find the *Elbe*, after it has quitted the long series of vallies into which I have described its entrance on its descent from the *Giant's mountains*; and in this last part of its channel, 18 leagues in length, from its bend at *Aussig*, across the chain of mountains which separates *Bohemia* from *Saxony*, I had no where seen, from any vestiges, that it had attacked its sides in order to straiten its course: on the contrary, I could here very evidently perceive this channel to have been originally intersected by openings so numerous and so wide, that the *Elbe* could not have risen perceptibly, in any part, without finding either on its right bank or on its left, other *vallies* which it might have followed, without being obliged to cut its way through rocks. As for its precipitous sides, it is manifest that they have not been produced by the action of the river, because the sides of the *vallies* and *combes* which open into the principal valley, and from which only rivulets proceed, are equally precipitous. The latter circumstance renders it almost impossible to observe any effects of *time* in this part of the channel of the river. Except in the defiles of *Aussig* and *Tetschen*, which are not of great length, the double *fracture* of the *strata*, and the *subsidence* of the intermediary masses, have produced a vacancy of sufficient breadth, along the whole course of the river, to have afforded it always

an easy passage during its greatest swells; and there are no spaces, at its own level, wide enough to have allowed it to form any of those *alluvial* soils which in other parts of its course, below this point, are seen to be still gaining in extent. The whole operation of the *Elbe*, therefore, in this deep valley, the sides of which consist of *stony strata*, has been to level its bottom by the sand brought down from the heights, and to deposit this sand also on the masses of *strata* remaining a little above the usual level of the water at the foot of the steep rocks; and thus have been formed the *terraces*, over which the river still spreads more or less, during its inundations, but without ever reaching the rocks, or even the slopes composed of the rubbish which crumbles down from them. These terraces are continuing to rise, in consequence of the accumulation of fresh sand upon them; but this accumulation makes too insensible a progress to furnish a *chronometer*. It is therefore only when the *Elbe* flows between hills composed of *loose strata*, that the *progress* of its operations is easily observable; this has been already seen in various parts of its course nearer to the sea, and farther instances will appear along another part which I followed as I continued my present journey.

Sept. 27*th*. From *Pirna* I set out in my chaise, at half past six in the morning, for *Dresden*, four miles distant; and the roads being good, I arrived there at half past nine. When large rivers flow through plains, there are three distinct states which may commonly be observed in the neighbouring soils, according to their differences of level. At the beginning of this journey, I gave an account of these states on the left bank of the *Elbe* at *Wittenberg*; but I shall here describe them again, as well because I am now speaking of a plain, as because new examples of them will appear on the sides of this river between *Dresden* and *Wittenberg*.

801. The first of these states is that of the grounds over which, though they are very little above the level of the river, it yet has never risen during floods; such grounds may easily be distinguished from the others which I shall mention, because, with respect to *blocks* and other stones, they do not differ from the higher soils in their neighbourhood; if any of these masses are scattered on the eminences, they are found also here, either placed along the borders of the fields, which have been cleared of them when brought into tillage, or dispersed over such parts as are still uncultivated. The second state is that of the grounds which, though but very little lower than the former, are covered by the river, (more or less frequently, according to their various heights,) during its inundations, and which it has levelled either by spreading the earth more equally over them, or by the addition of its own sediments; under the soils thus formed, the blocks have in great part been buried; but some are seen, here and there, to rise above the surface. Thirdly, at the

lowest level are the *alluvial soils,* formed by the sediments of the river on the borders of its own bed; these sediments being chiefly deposited in the wide parts, where the course of the stream is slackened when it overflows. The latter soils are become meadows, which, when raised above the level of common inundations, have been enclosed with *dikes,* for their protection against the extraordinary swells of the river. Now these *dikes* form a large class of *chronometers;* for it is known by tradition at what period each of them was first constructed.

802. The hills on the left become gradually lower; but I travelled for some time on that side over a high ground, where a large creek bordered with *cliffs* has been formed by the river, which here makes a sudden bend, and strikes against its bank at a particular point. All the ground on the opposite bank is low, and has been levelled to a great extent; and the *Elbe* would have continued to widen this creek, had not its current been repelled by large piers, on account of a village which lies behind, and which the postillion told me was called *Heidenhaus:* since the stream has been thus turned, the cliffs have been reduced into slopes, and covered with grass. I had observed *blocks* of *hornblende* on the road; and on arriving at the village, I saw there heaps of *blocks* of various kinds, which had been collected together for the purpose of building; among these there were some of differently coloured *granites,* of *sienite,* of *red porphyry,* of *gneiss,* of *granulated*

quartz, and of *grey wacke*, all taken out of the neighbouring fields. That it is not the *Eble* which has disseminated these *blocks* may easily be judged; for, from the above precise description of the different soils on its borders, and of their respective levels, it is evident that the river can never have risen over these grounds, especially as this is a part of the country in which, from the first, it has had sufficient space to spread.

803. I here quitted the banks of the river, and proceeded by a strait road to *Dresden*, where I arrived at half past nine; I stayed five days at this city, in order to enjoy the company of the persons from whom I had before experienced so much kindness; and I found here also the worthy Count Ch. Von Bruhl, with whom I had contracted an intimacy at *Berlin*. It being my intention to follow the course of the *Elbe* down to *Wittenberg*, I engaged, for this purpose, a covered boat, with a sail and two rowers, and I caused my chaise to be put on board it.

Oct. 3d. I embarked at *Dresden* at 11 in the morning for *Meissen*, three miles distant, which was as far as I purposed to go this day. The current of the *Elbe* is in this part so slow, that, with the assistance of two good rowers, I did not reach *Meissen* till four o'clock; and the water is so shallow, that these men often laid down their oars, and pushed on the boat with poles.

804. On quitting *Dresden*, I found myself in a large basin, formed by the retreat of the hills on both sides. When I stood on the deck of the boat, which raised me about 10 or 12 feet above the level of the river, I could see the original banks, to a greater or less extent, either on one side or the other, and sometimes on both; at the same time, I saw likewise the alluvial soils, behind the dikes which secured them. At a league's distance from *Dresden*, near the village of *Pritznitz*, I came to a very wide *cliff* on the left bank, with the *Elbe* flowing so near its higher extremity, as to prevent any slope from being formed there by its falling materials; so that its foot was still open to the attacks of the river during floods. However a *beach* composed of the stones which had fallen appeared already above the water. Whenever, therefore, this part, continuing to crumble down, shall have retreated a little farther backward, it will soon arrive at the same state with the rest of the cliff, which is already reduced into a slope, and covered with grass. This *cliff* is the extremity of a ridge of hills, advancing towards the *Elbe*, and cut off abruptly on its border; while the opposite part of the right bank is formed by a continuation of the low grounds extending to the foot of some steep hills at a distance, which are much intersected, and are planted with vines: some way below, these hills come down to the river-side. In passing before the above-mentioned *cliff*, I perceived it to be the section of *strata* of a soft *loamy* stone, which is easily worn away by the actions of the

air,

air, and of which the harder parts compose the *beach.*

805. Below *Kötschenbroda*, on the right bank, there is a piece of higher ground, which the *Elbe* has likewise attacked, and reduced into a *cliff.* A great deal of gravel having been here contained in the soil, it has formed a *beach*, in this part, along the river-side, and is continuing to accumulate at the foot of the cliff. The *Elbe*, having an open space on its left bank, has retreated from this obstacle; and whenever it shall have bent its course in a sufficient degree, the *cliff* will attain a fixed and permanent state. The river, being thus repelled towards the hills on its left bank, appears, from a certain distance, as if it were about to pass through a cleft in those hills; but, on a nearer approach, I found that, from the foot of the hills on the right bank, which it had sapped above this point, it had carried to the left such a quantity of gravel, as to have formed there a high *beach*, whereby it is driven back to the right. Before this *beach* was raised, a part of the soil which now lies within it had been covered by the river with sand and with mud; and being consequently converted into good meadow-land, it has been thought worth the trouble of protecting: across the beach, therefore, has been carried a spur-work of timber, forming low piers, inclined in the direction of the stream, and covered with stones on the side opposed to the current, which is thus turned off without difficulty.

806. The hills on the left bank, which are here covered with brush-wood, are much intersected with deep vallies or combes. The right bank for some way continues low, forming a plain; but this afterwards contracts, and at last the hills advance to the border of the river in a large rocky promontory, in which I observed some quarries; the stone taken out of them is a *reddish granite;* but it is so much shattered, that no large masses of it can be obtained. The *Elbe* here makes a turn, and passes between two ridges of hills; those on the left bank are continuous, and very abrupt on the side next the river; they are intersected only by some large fractures, in which rocks appear amidst the brush-wood covering the slope. The opposite bank has a quite different appearance, presenting a succession of pyramids, the slopes of which are formed by the rubbish of their higher rocks: these slopes are prevented from sliding downwards by low walls built across them one above another; and they are planted with vines on their southern side.

807. The *Elbe* is far from occupying the whole of the interval between these parallel ridges of eminences, both composed of *granite*, yet so dissimilar in their form: it has levelled the bottom of this interval with the materials which have fallen from its sides, and have been set in motion by its waters; but it flows sometimes towards one side, and sometimes towards the other, not preserving a strait course; and as I went down the river, I observed

that, at every bend, the soil was high on the outer side, and low on the inner, where it formed meadows. The preceding descriptions have afforded proofs, that the *gravel* which rivers flowing in plains detach from their borders is not transported by them to any great distance, but remains on their beds; and that the gravel found on these beds is always the same as that on their borders, and commonly belongs to the soil of the neighbouring country. Now here I met with an exemplification of the former remark, independently of the latter. Above the part where the *Elbe* thus flows between rocks, I had observed, on its bed and on its borders, a *gravel* composed of stones of various kinds, the same being also contained in the neighbouring soils, where these masses were already *rounded.* But in this confined space, where there were no stones on the borders of the river but *angular fragments* of the *reddish granite* of the rocks, the bed of the stream was for some way covered only with these *fragments:* and I shall point out the precise place at which they disappeared.

808. Some time before I reached *Meissen*, I had on the left a long hill of *granite*, the abrupt front of which was still continuing to crumble down; but, on the right bank, the country was quite open. At first, I saw nothing of *Meissen* but the castle, with some houses built around it, on a very high rock which is cut down abruptly towards the *Elbe;* but when I approached the town, I suddenly perceived

the rock was separated from the body of the hill by a cleft well worthy of a particular examination. At four o'clock I reached *Meissen*, where I had intended to visit the celebrated manufacture of china, which is on the same hill with the castle, and mostly within the precincts of the latter; but fearing lest the fine weather should fail me, and having still a long voyage to make on the river, I thought it better to employ the remainder of the day in observing this opening into the interior part of the country. On arriving opposite to the entrance of the cleft, I saw a brook, which issues from it, flowing very calmly to join the *Elbe*, having already, at a remote point, in its own valley, descended to the level of this river: as it was my intention to ascend that valley, and view the adjacent grounds, I engaged a guide to attend me thither.

809. The cleft is narrow at its entrance, but becomes wider within. The town of *Meissen* is built on the left bank of the *Elbe*, and covers the lower part of the castle-rock, behind which it extends some way, ascending the slope on that side towards the castle. The right bank of the brook, formed by the granitic hill, is very abrupt; the lower part of its slope is studded with rocks, of which the intervals are covered with turf; and its upper part is laid out in vineyards. My guide led me up to the summit of this eminence by the very steep paths used by the labourers, and I was not a little surprized at the variation which I here found in the soil. That

of the whole slope, including the vineyards, up to the top, consists entirely of *granitic rubbish;* while that of the summit, which has been brought into cultivation, is the common *heath-sand*, not mixed with any *fragments* of *granite*, but only with *gravel* and larger masses of *white quartz;* and this sand appeared to me to be very deep: yet it will be seen that the eminence itself is insulated, and that consequently this soil, which is absolutely extraneous to the *granite* beneath it, cannot have been transported hither from any quarter, since the continent has been abandoned by the sea. This is a phenomenon of which I have already given many examples, and it renders the *loose* superficial *soils* of countries consisting of *stony strata*, an object worthy of very great attention, since it shews the variety of the catastrophes and other operations which took place on the bottom of the *ancient sea.*

810. I first proceeded along the brow of this eminence on the side next the *Elbe;* and as from hence I commanded most of the hills which I had seen bordering this river on its opposite bank, I could judge very clearly that at the time when its waters were first collected in a stream, if it had not found prepared for it the lower channel wherein it at present flows, it would have passed behind these eminences, which, in that case, would have stood on its left bank; for they rise, separately from each other, in the front of a large plain, where the river might have freely held its course, and have after-

wards entered its present channel lower down, near the villages of *Nieder-Côln* and *Spare*. But from the right bank advances a promontory of granite, in front of that on which the castle stands; and a bridge resting on the summits of these two opposite eminences is here thrown across the river. It was probably the advantage of thus establishing a communication, for all seasons, between these opposite banks, which occasioned the erection of the castle of *Meissen*, and afterwards of the town; and the latter has since been much increased, in consequence of the flourishing state of the china manufacture.

811. After having made these observations on the side next the *Elbe*, I crossed the hill to its opposite side, where I found it cut down abruptly towards the valley which separates this eminence from the rest of the granitic ridge, and which is so wide, that the *Elbe* itself might have found room to flow in it, though it is pervaded only by the brook that joins this river at *Meissen*, after issuing from a cleft higher up; this brook was at present so inconsiderable, that, having descended into the valley in order to observe it, I stepped across it in several places. The eminences surrounding this large space are much intersected; by which a very profitable addition is made to the superficies of the ground on the same horizontal base. All the sides of the hills with a favourable aspect are laid out in vineyards supported by low walls built across the slopes of rubbish: the sides less advantageously situated are

covered with woods or coppices; and the intervals between the eminences are occupied by meadows. On the brows of the hills, there are still some rocks that continue to crumble down; and their rubbish has formed slopes, which are not yet bound by vegetation, because the materials had a great way to fall, before they found a base whereon they could accumulate.

812. Though the brook is so inconsiderable, and though there is so wide a space over which it is free to spread, yet, as it has not preserved its course in the middle of this space, it attacks at one point the foot of the hill whence I had just descended; and when it overflows, it saps the base of the slopes of rubbish, the surface of which, being thus occasioned frequently to slide down, I observed to be still bare. But in the parts where the foot of the hill is seldom reached by the stream, the rubbish is retained by the asperities of the section of the *granitic strata;* and there I found the slopes more fixed, and covered with vegetation. In these very parts, however, when the brook, during an extraordinary swell of its waters, attacks at a high point these slopes which are thus cut across by the edges of the strata, one portion of their surface slides down upon another, in the same manner that a cascade falls from rock to rock; and the plants which have overspread them perish. My guide told me that, on such occasions, the paths leading up these slopes towards the vineyards are carried away;

and he shewed me some places where, having been thus destroyed by the great inundation of the preceding winter, (which I have so frequently mentioned,) they were not yet repaired.

Oct. 4th. I embarked at six o'clock in the morning, and at three in the afternoon I arrived at *Torgau*, six miles distant. In passing under the very high bridge which I mentioned as forming at *Meissen* the communication between the two banks of the river, the boatmen told me that the winter before, the water had risen to the top of the arches, that the lower part of the town had been mostly inundated, and that the water of the *Elbe* had ascended a considerable way in the channel of the brook which I had observed the preceding day.

813. After having passed the bridge, I saw, on the right, an open country of great extent, being a continuation of the plain which lies behind all the eminences bordering that bank above this part of the course of the river. This space shews the nature of the catastrophe which produced both the valley of the river, and the plain itself. It was on the present left bank of the *Elbe* that the principal fracture took place, and was followed by the greatest immediate subsidence; this subsidence extended so far as to form the plain on the right bank; but, along the great fracture which happened on that side, some masses remained at a higher level than the rest; and these, having undergone angular motions,

are now the *pyramids* of *granite* by which the left bank is bordered here, as it is, above *Pirna*, by those of *sand-stone*.

814. After I had gone some way farther down the *Elbe*, I again saw hills rising on both its banks, which exhibited *chronometers* of two different kinds. Those on the left bank shewed the *progress* of the effects of *natural causes*, in the formation of *slopes* of *rubbish* under the rocks, and the fixation of these *slopes* in several places by the growth of trees and bushes; while in other places the process was not yet terminated, because the rocks still crumbled down too frequently to permit the plants springing up on the *slopes* to rise to any height before they were covered with fresh *rubbish*. On the right bank, of which the aspect is favourable for vines, appeared the *progress* of *cultivation*. There the owners of the land, not waiting till the *slopes* of *rubbish* should be fixed by acquiring the requisite degree of declivity, had built low walls to support them at different heights; and in this place I saw repeated the operation which I have described, with many details, in my *Lettres sur l'Histoire de la Terre & de l'Homme*, as one of the means employed by industry to render more productive the surface of the earth. The rocks above continue to crumble down on the highest terraces, and in several other places, as well as here, they are cut at the foot, for the purpose of making them crumble the faster. By tronching these terraces in the spring, each of them,

in its turn, is made to supply that below it with the necessary quantity of this rubbish; and as the operation extends the whole way down, the lowest of them is every year raised by the portion of soil which in this manner is brought down to it. Thus, in such parts of the feet of mountains as have a climate and exposure favourable for vines, art accelerates the operations of nature, by causing the higher rocks to crumble down more rapidly, and lessening the declivity of the *slopes*. I explained, in my first Travels, that, wherever the rocks above have ceased to crumble down sufficiently, or some obstacle below prevents the extension of the slopes, so that their declivity cannot be any farther lessened, the vine-dressers, every winter, carry up to the highest parts of the vineyard the earth which they had thrown out in trenching it the preceding spring; an operation always begun from the bottom; and thus the same quantity of soil is constantly preserved on each of these terraces, which are divided by little walls across the slope.

815. Thoughout the whole of this tract, the course of the *Elbe* is nowhere confined, except between the opposite promontories at *Meissen*, and there only when it is swelled; below this point, it winds through large open spaces, approaching sometimes one bank, and sometimes the other, but without attacking either; for its borders are grassy, and it has formed some islands on its bed. The left bank is very picturesque, from the forms of its *granitic*

rock, and their reddish tint, which make a very agreeable contrast to the verdure of the trees interspersed among them. Their *strata*, where but little inclined, may be easily distinguished; but, where inclined so much as to be nearly vertical, which is the case in some masses of these rocks, it is impossible to distinguish them, so much have they been broken and subverted by the catastrophes which have reduced them to this state. The river is so shallow in some places, on account of the wideness of its bed, that I saw a woman cross it in a little boat, with a very short pole.

816. These picturesque rocks on the left bank become gradually lower; and at last they disappear, at a point where a large valley opens just above the village of *Zehro*. Below this, the rocks again rise on both sides, but with many interruptions, so that frequently one bank is open, while there are rocks on the other. On the most projecting rock belonging to the left bank stands the castle of *Hirschstein*, or the *Stag-rock*, as I had before occasion to explain, when I mentioned another of the same name at *Carlsbad*. This is the last of the *granitic* eminences on the left bank; beyond it, the country becomes low. After having passed *Morschwitz* on the right bank, I arrived before *Leutewitz* on the left. Below this, I again saw some insulated rocks of *granite* on the right bank, the intervals of which afforded me occasional views of the interior part of the country; but the last of the promontories on this

side advancing towards the *Elbe* is composed of strata of loose *sand.* After this, scarcely any more *granite* appeared externally; but, from what has been seen above, it certainly must prevail under the sand that covers the whole country; which is farther indicated by the form of the ground, consisting of hills and vales, whence it is evident what must be the state of the *granitic strata* within; and all these hills are scattered with *blocks* of *granite*, and other *primordial stones.* A great way beyond this, however, I thought I observed, below the village of *Riesa* on the left bank, another rock of granite, on which, near the river, a house was built.

817. I now again beheld all the phenomena of *sandy* countries, and of the banks of the rivers which flow in them. The *Elbe* is here confined in several places, either on one side or on both, by the dikes of *alluvial soils.* Lower down on its course, I saw frequently soils of the kind which I have generally described as having been levelled by the river, when spreading to a greater or less extent during its inundations, before its channel was fixed. It afterwards again flows between sandy eminences, still wearing away some parts of both its banks; and as these consist of *strata* of *sand* intermixed with others of *marl* or of *clay*, the materials which fall from them are carried down by the river, and contribute below to the formation of *alluvial soils.* Wherever it has been thought worth while to secure these soils, on account of their vicinity to inhabited places, this

has been effected by low spur-shaped piers, such as I have already mentioned, which are made obliquely in the direction of the course of the river, and have their higher side much inclined. When these piers are at a small distance from each other, they have the double advantage of throwing back the current of the river towards the middle of its bed, and retaining the sand in their intervals; and this produces a strand, on which the materials falling from the cliffs being retained, the latter are reduced into slopes, and covered with grass; while the strand itself, being under water during floods, becomes grassy likewise, and the river has no longer any other action on it than that of raising it by the deposition of fresh sand. But, in the parts against which the current still bears too directly, the cliffs, continuing to crumble down, are yet naked.

818. I had opportunities of observing all these modifications, as I continued my voyage down the *Elbe.* I now came to a large space where no high ground appeared within sight; this space extended as far as the small town of *Strehla*, situated on the left bank, on the foot of a high hill, along which the river passes, making a bend to the right. All this part of the country is *sandy*, and the woods consist of *pines;* but there are a great many *oaks* in the *alluvial soils*, and likewise in those which the river has levelled during floods.

819. Here I observed the proof which I men-

tioned above, that gravel, never travelling far in plains, is consequently not carried down by rivers to the sea. I had passed but a little way beyond the *granitic* hills which border the *Elbe* in the upper part of its course, when I ceased to perceive any of their rubbish, either on its bed or on its borders; nor could I be mistaken in this respect, because of the redness of that *granite*, and the angular form of its fragments. From the point where the river entered this *sandy* country, I observed in it no other *gravel* than that which is contained in the *sand*, and is composed of stones of various kinds.

820. Below a certain space, the soils on the right bank rise in hills of *loose sand* covered with *pine* woods; I saw these begin a considerable way before I came to *Mühlberg*, a place situated on that bank. The land being here of little value, on account of its distance, even from any large villages, the *Elbe* has been left to its own spontaneous operations, or at least has been very little assisted in them. In this part may be seen in what manner the *alluvial soils*, and some *islands* on the bed of the river, have been produced. The sand is deposited wherever the stream, although swelled, possesses little rapidity; and as soon as the soils thus formed have risen to the level of the river in common seasons, their moisture promotes the growth of reeds and osiers, which, during floods, oblige the water to slacken its course between their stalks, where it consequently deposites an additional quantity of mud; in this manner these

new grounds are at last raised to the height of the greatest inundations; after which they spontaneously become meadows, interspersed only with bushes of osier; for the reeds perish, as soon as their roots are above the level of the water in common seasons. In those parts of the shores of the river, or the islands, where this operation does not happen to take place, it is imitated by the labour of man; and this is the only respect in which natural causes are assisted throughout the whole of the above space, the elevation of such soils as are still too low to be converted to any use being accelerated by planting on their surface small stakes of osier very near each other. After a few inundations, these stakes are almost entirely buried under the sediments of the river; but having, in the mean while, taken root, their branches continue to detain the sand and other substances floating in the water, till they have gradually raised the soil to the level of the highest floods; after which, it may either be converted to use in the intervals of such floods, or else be secured against them by dikes. The same expedient is employed also to fix the *dunes*, or sand-hills, either along the coast, or in countries consisting of loose fine sand; sometimes slips of birch, which likewise readily take root, are used for this purpose, sometimes merely some pieces of straw; for the sand carried about by the winds will lodge between either of these, until bound by the roots of the grass springing up on it in rainy seasons.

821. It was two o'clock when we arrived at *Mühlberg*, which is at the distance of four miles from *Meissen*. As the name of this village terminates in *berg*, I had expected to see it placed on an eminence; I was therefore surprized at finding it situated in an *alluvial soil*: I landed for the purpose of observing this soil, which is secured, on the side next the *Elbe*, by a strong stone dike, consisting of fragments of *wacke* of various colours. The whole tract is intersected with large ditches which are terminated by sluices in the dike; they had not at present any water in them, because the level of the river was low. On the outer side of the dike, I saw a strand formed by the *gravel* which the stream impels against it, and which consisted of *wacke* of various colours, *white quartz*, *granulated quartz*, and *grey granite*; the same stones being found in the soil of the whole country.

822. From *Mühlberg* we continued our course for about two hours; but a contrary wind had sprung up, which already much impeded our voyage, and the next day put a stop to it. The shores of the *Elbe* continued to be very low, till I approached *Belgern*, a village situated on the left bank. Here the course of the river has been opposed by the extremity of a hill, which it has attacked and reduced into a *cliff*; but this cliff is rapidly wearing down, because the *sandy strata* of the hill being intermixed with *argillaceous strata*, the water which filters through the former is retained by the latter, till it

softens the whole mass; so that, in rainy seasons, the *cliff* crumbles down in large pieces. In consequence of this, a large cove has been formed here, to the extension of which it will in time become necessary to put a stop, by repelling the river in this place in the customary manner; for *Belgern* is situated in an inflexion of the shore very little below the point thus attacked, and is secured only by the part which still remains of the original soil at the extremity of the cove on that side. There were formerly some *cliffs* below *Belgern;* but they are now reduced into slopes, and covered with grass.

823. After passing these cliffs, I found the soil low on both the banks; sometimes it was the original soil coming down to the river; but more frequently alluvial grounds enclosed with dikes; of this latter kind there are many islands, and particularly a very large one opposite to *Torgau,* a town situated on the left bank. As I now saw nothing, even from the deck of my boat, but lands similar to these, I was the less concerned at the bad weather which came on, and obliged me to retire into the cabin. We now had not only a contrary wind, but so violent a storm arose, that we were obliged for some time to lie close under one of the shores; on which account we did not arrive at *Torgau* till eight in the evening.

Oct. 5th. Being detained the whole day at *Torgau* by the continuance of the same wind, I employed this time in observing the adjacent country. The castle and part of the town are on a mount which is encompassed by an extensive tract of *alluvial soil*, secured with a strong dike. The waters of this tract are discharged in part by a canal crossing the lower part of the town, and terminated by a sluice in the dike. The streets are paved with *rounded stones*, among which I saw several kinds of *granite*, mostly red, but some grey, red and greenish *porphyry*, and *wackes* of different colours; I saw likewise *blocks* of the same species along the houses, to keep off the wheels of the carriages; and on inquiring whence these stones came, I was told that they were found in the sand of the neighbouring hills.

824. Advantage has been taken of the large *alluvial island* surrounded with dikes, immediately in front of *Torgau*, to form here a permanent passage across the *Elbe*. From the town to the island there is a bridge, which is supported by stone piles in the part nearest to the main land, and is covered with a roof of boards. Another bridge passes from the island to the opposite bank; and the branch of the stream which it crosses is called the *Old Elbe*, probably as being on the side where the principal current of the river formerly lay; but this branch having been contracted by the extension of the island, and of the *alluvial grounds* on the right bank, the chief current, which is also the straitest, is now on the side next *Torgau*. Several other streams had been formed beyond that of the *Old*

Elbe, but they have been choaked up since the principal current was thus changed; the mouths of these may still be seen near the villages of *Zweta* and *Rosenfeld;* but the rest of their bed is filled up.

825. The bridge being of considerable height on the side next *Torgau*, it commands a view of a vast tract of low grounds along the course of the *Elbe;* some of them are enclosed with dikes, and others, which are merely levelled by the river, extend, on the land side, to hills at different distances. Over all this tract the *Elbe* formerly spread itself, lowering the highest parts, while it elevated the lowest with the materials of the former, and with the muddy particles brought down by its waters during innndations. Having had this prospect of a great part of the country through which I was to pass the following day, I was aware that I should lose nothing essential if confined by bad weather to the cabin of my boat; I therefore resolved to embark the next morning, and proceed by water to *Wittenberg*, as I had originally intended; because, the distance being only four miles, I hoped to be able to reach that place in the course of the day, even though the wind should still continue unfavourable.

Oct. 6th. I embarked at *Torgau* at seven in the morning, passing at first between the *alluvial soils* adjoining to the town, and the large *alluvial island.* Along all the shores, I saw only osiers and reeds; but farther inland I descried some large oaks and

poplars,

poplars, which indicated grounds merely levelled by the river. I remarked that in the parts where the stream had a tendency to bear against either side, stakes had been planted in front of the osiers, the branches of which had been interwoven between them; and the water, during the inundation of the river, being calm behind these stakes, its mud was deposited there, and thus, in time, a real dike was raised. I saw likewise that, wherever a *beach* had been formed on the side opposite to any of these alluvial grounds, longitudinal channels had been cut in it, for the purpose either of taking out gravel for various uses, or of determining a part of the river to take that course in its inundations, in order that, its stream being thus diminished, it might less forcibly attack the dikes.

826. There being no other considerable stream within a great distance of the point where the *Elbe* enters these vast plains, it has been found necessary to employ this river in grinding corn for the neighbouring inhabitants. The mills are constructed on two boats strongly fastened together, between which the wheel is fixed; so that it is always at the same level relatively with the surface of the water, whether the latter rises or falls; and as these mills are placed in parts where the current passes near high grounds, the boats are moored to the shore with strong chains on the side against which the current bears; and in order to retain them on its course, they are fastened to poles planted in the bed of the stream: thus the

wheel is turned by the current; but if the latter, when greatly swelled, becomes too violent, the boats are loosed, and the current itself carries them to the shore, where they enter a recess made for that purpose.

327. About ten o'clock, the contrary wind became so violent, that it was impossible to row against it; so that we were obliged to go on shore, near a gravelly strand on the right bank. I would not at first have my chaise taken out of the boat, because the boatmen thought that the wind might change at noon; and besides, no horses were here to be had, without going to some distance to obtain them from the farmers; but I landed myself, and began to stroll over the neighbouring grounds. I found here a great extent of horizontal land, open, and entirely uncultivated. This land was covered with grass, except in the parts over which it might plainly be seen that the *Elbe* still spread whenever it overflowed; and there, in some furrows made by the stream, I could see that the soil consisted only of sand mixed with gravel. That this river formerly spread much farther inland during its inundations, may be judged from the great extent of the ground that it has levelled; and I shall presently describe a tract which, though formerly attained by it, is now no longer within its reach, and which shews very evidently that the stream, by excavating and straitening its bed, has lowered its level about 10 feet. In the part where I had now landed, the soil was

chiefly

chiefly planted with wild pear-trees, and with a few oaks and beeches; nearer the river, there were only a few bushes interspersed among the grass, which served for pasturage; and in the lower parts, where the *Elbe* had deposited its muddy sediments, there were meadows.

828. Here is seen an example of what has every where taken place on the low grounds which lie near the course originally followed by large rivers, and which at first were within the reach of those streams, though the latter, having sunk their channels to a greater depth, have now ceased to spread so far: it is only in the lowest parts of these grounds that any muddy sediments have been deposited; for where the soils are gravelly, as is the case here, the waters, instead of enriching in this manner the higher parts, have, on the contrary, washed away from them the earthy particles mixed with the gravel, leaving nothing behind but the sand spread over the surface by the last inundations which extended so far. It is on this stratum of sand that vegetation has here taken place; the trees grow in it very well, and the grass beneath them serves for pasturage: a large herd of cattle was at this time feeding here, and goats were browzing among the bushes. It is owing to these bushes, that the surface of the ground is not perfectly level; because, during extraordinary floods, the sand is deposited betwixt their branches, and a small hillock is thus gradually raised around each bush. I could easily judge how far the inundation

of the preceding winter had extended here, because, a great way within this wood, I saw a quantity of *fluviatic muscles* scattered on the ground, and still quite fresh.

829. But the following circumstance will directly shew that an absolute depression of the level of the *Elbe* has taken place within the course of a few centuries. The horizontal zone above described is bounded by lands insensibly rising to the foot of the neighbouring hills, and extending on both sides as far as the eye can reach. Now on the line where these lands begin to rise, I saw the remains of *dikes* which had formerly served to secure against inundations a zone as horizontal as that bordering the river, but at a level a little above it. These *dikes* having now become useless, because the stream, when most swelled, no longer rises to this height, they have been cut through in several places, to open communications between the arable lands on the highest zone, and the meadows on the lowest.

830. On my return to the boat, the boatmen told me that there was no chance of our being able to proceed any farther down the river this day, but that the wind was exactly favourable for their return to *Tetschen* with their sail; they therefore proposed to land my chaise, and to borrow horses for it at the village of *Treben*, which stood at a little distance on the higher ground, that I might continue my journey to *Wittenberg* by land. I could not have refused to

comply with this proposal, unless I had chosen to remain in the boat till the wind should change; but indeed I was glad of the alteration in my mode of travelling; because I judged that, from the river, I should see nothing but a continuation of the same low grounds, and that it would therefore be better worth my while to observe the interior part of the country. Whilst one of the boatmen was gone in quest of horses, and the other was bringing my chaise on shore, with the assistance of some people belonging to a boat which had been stopped there like our own, I employed myself in collecting the various kinds of *gravel* here scattered on the shore of the *Elbe;* this was the same *gravel* which I had already observed to belong to the soil of the higher grounds and the arable lands at their foot; but on the banks of the river, where it had been washed quite clean, and was now wet, its colours were so brilliant, and consequently so distinct, that I could scarcely pick up a sufficient quantity of it to be satisfied that I had taken specimens of every kind. I found here a great variety of species of every class of stones, *granite*, *porphyry*, *micaceous schistus*, *gneiss*, *hornblende*, *white quartz*, and *granulated quartz*, all evidently proceeding from the soil through which the *Elbe* has cleared its course, and which extends over the neighbouring hills; I even met with some *flints* here, though, throughout all these countries, there are not the slightest vestiges of any *chalky strata.* Now this part of the course of the *Elbe* is only an example of what may be found along all the rivers which flow in plains; evidently proving that streams transport nothing from high grounds to the sea, except such minute particles as float in running waters.

831. My chaise was ready for me by half past one; but the farmer, from whom the horses were obtained, would not allow me to take them any farther than *Brettin*, where he assured me that I should find others with which I might proceed to *Wittenberg*; but he was mistaken: I reached *Brettin* at three o'clock, and no horses were to be had at that place till the next morning; so that I was obliged to spend the remainder of the day there, and all that I could do was to employ in observations as much time as the rain, which again came on, would permit.

832. In my road to *Brettin*, I first crossed all the horizontal soils planted with trees, and ascended the heights at a greater distance from the *Elbe*; then proceeding in the direction of the river, I came down into a spacious tract which consisted of meadows of mowing grass, intersected with ridges of higher ground affording only pasturage. This tract is in no part secured with dikes, and it does not appear to differ from the low space over which I had previously passed, in any other respect, than that, while most of the surface of the latter is above

the inundations of the *Elbe*, here no parts had been originally at that height except these ridges; but their intervals are now so much filled up with the sediments of the water, as to be above its level at all times except during extraordinary swells of the river, which even then cannot pass over this tract with rapidity, because of the ridges.

833. Having afterwards crossed a space very low, but not enclosed, I came to a dike which begins from the river side, and advances inland a considerable way, enclosing laterally an alluvial soil that extends to a great distance down the *Elbe;* above this *dike*, the stream has been left at liberty to spread: the rain-waters descending from the heights are received in a canal following the dike, which is continued along the alluvial soil on the land side; this soil chiefly belongs to *Brettin*, a large village situated in that part of it which lies at the greatest distance from the river. Here the richness of these grounds is shewn by a long double row of handsome barns, wherein are laid up the hay and the corn produced by a particular tract which I shall presently mention. To arrive at the village, I passed over the lateral dike. In front of the barns, there is a pavement composed of very large stones of all the species which are found in the *sand* of the neighbouring hills; it rained when I reached this place, so that I could not, for some time, go to walk on the outer side of the dikes; but, in the mean while, some amends were made to me by the beauty of

many of the masses of *granite* and *porphyry*, to which the water that covered them served as a kind of varnish.

834. The rain ceasing for a short time, I took advantage of the interval to pass beyond the dike which borders this alluvial tract on the land side. The hills here are not very high; but, on ascending them, I had a view of the whole of this vast space, entirely surrounded with dikes, which are all bordered with canals, as well as the higher one, for the purpose of receiving the water from the interior part of the country: a part of this water is led to the river by the canal left open to it along the lateral dike, over which I had passed to enter these grounds; but the greater part is carried across the alluvial soil by canals bordered with dikes that internally divide it, to openings in the dike nearest to the river, which may ascend into all these canals when the sluices are open: the rain-waters falling in this enclosed space are also carried by the same channels into the *Elbe*. The low horizontal lands, over which, as I have said, the river passed at a former period, here extend behind the dikes; and this, though it consists of sand, is the tract mentioned in the preceding paragraph as so abundant in its products; its fertility being occasioned by the quantity of manure, which is supplied by the cattle fed in the meadows, and is carried a considerable way over those higher parts that would either be planted with trees, or would supply only pasturage, if their

situation were not attended with this advantage. I had not proceeded far on these high soils, when the rain came on again with great violence, and obliged me to return to the village.

Oct. 7th. I set out from *Brettin* at half past five in the morning, with the intention of reaching *Belitz* in the evening, that I might thus be able to arrive at *Berlin* early the next day; but unluckily no horses were to be obtained except those of the farmers, which were all now employed in ploughing; and were so bad, that I was obliged several times to change them on the road, sending to villages at a considerable distance in search of fresh ones, which proved no better than those that I left behind, in the charge of some countryman, till the driver should return to take them back to their owners; and thus, though it was only three miles to *Wittenberg*, I did not arrive there till three o'clock.

835. On setting out from *Brettin*, after having crossed the horizontal soils on the outer side of the dike, and travelled some way on higher ground, I turned to the left, and proceeding in a direction parallel to the course of the *Elbe*, I came first to some other soils nearly horizontal, which were tolerably fertile, and were interspersed with meadows. At *Jessen*, I crossed the *Schwartze-Elster*, (or *Black Elster*,) a stream flowing to join the *Elbe*, and distinguished by this name on account of the *dark* colour imparted to it by a peat-moss from which it

issues: having, however, taken up some of its water in a glass from a part where it looked the darkest, I found it perfectly limpid, notwithstanding the rain of the preceding day. I saw no *blocks* on these soils; yet there were some in the villages, whither they had undoubtedly been brought from higher grounds. The lands become lower towards the village of *Elster;* but though they are cultivated and tolerably fertile, yet, as they belong to the tract over which the *Elbe* has not spread since it has been reduced to its present level, they are not enclosed with dikes: on the opposite bank there are similar lands, some forming meadows, and some planted with trees. During extraordinary inundations, these grounds must be overflowed; yet I saw on them a few hamlets, probably in parts a little above the level of the rest. Near *Elster*, the *Elbe* has a tendency to attack and abrade its bank; and the soil being gravelly, a *beach* is formed at the foot of the bank, in the parts where the *gravel* is pure: in this beach I saw the same kinds of gravel as in the neighbouring fields, which are however very fertile, as it is there mixed with a great deal of earth.

836. It was near one o'clock before I could set out from *Elster* for *Wittenberg*, where I arrived at three. I followed, for a long time, the course of the *Elbe*, here forming a large cove, beyond which begins, on this side of the river, a very extensive tract of *alluvial soils* bordered with dikes; these soils, now covered with meadows and planted with

oaks, must evidently have been added to the original low grounds of this bank, since the time when the latter were levelled by the inundations of the river; for the line of their junction may be traced by the small *cliffs* which here and there remain to mark it. The higher grounds are in tillage; but they are very inferior in fertility to this tract of later formation: their grassy surface appeared to me to consist of *peat;* and the only trees on them are some willows, which have been planted on their border along the sides of the alluvial meadows. Wherever I approached this border, I found nearly the same difference as at *Elster* between the level of these grounds, and that of the alluvial soil, to which, in several places, they descend in a grassy slope. The inhabitants have taken advantage of this declivity, by constructing mills at the lower extremity of the course of some brooks, which at first flowed directly to the *Elbe;* the water, from the part where its level is the highest, is led to these mills by wooden troughs; and after it has thus passed over their wheels, it crosses the alluvial soil between two dikes, and falls into the *Elbe* by sluices in that bordering the river. As I proceeded along its right bank, I found the alluvial grounds terminate a little above *Wittenberg*, where the soil of this bank being sandy, it is reduced, by the river beating against it, into a cliff; and the stones that have crumbled down have formed a wide beach, over which lies the road to the town. In this cliff I saw projecting several *blocks*, chiefly of *granite*, and at its foot were accumulated many others that had fallen from it: I afterwards saw great numbers of them along the streets at *Wittenberg*.

837. At three quarters after seven, I set out from this place for *Treuenbrietzen*, three miles distant, where I arrived at nine o'clock at night. Immediately on quitting *Wittenberg*, I came upon a causeway raised above the level of the meadows, across which a brook flows to join the *Elbe*, and which are consequently inundated, like those of that river, whenever it overflows. This causeway is bordered with *blocks*, brought undoubtedly, as well as those placed along the houses at this end of the town, from the large cultivated slope of a hill which I afterwards ascended; for I saw none left on this slope near the road, though vast quantities were scattered on the summit of the hill, which is a heath interspersed with woods of pines and birches, and with spaces where the sand is perfectly loose. The cultivated parts of this hill exhibit very little fertility, and some spots are so much covered with *blocks*, that it has not been thought worth while to clear them for the sake of obtaining only a scanty product. Above the heath I saw rising some *blocks* of *granite*, which were from 7 to 10 feet in length, and of which, perhaps, the larger part was buried in the ground. I then came to one of the spaces where there were no *blocks*; but after having passed an inflexion of the soil, I again met with those masses in great abundance. These alternations of

spaces in which there were such quantities of *blocks*, and of others where there were few or none, were repeated till I reached the half-way house, where my driver stopped to feed his horses. Here the night closed in, as it had done at my arrival at this very place, on my way from *Berlin*, at the beginning of my present journey; it thus happened that I observed the whole road, though at different times; and over that part of it which I had seen before, I now travelled in the dark. From *Treuenbrietzen*, I set out at 10 o'clok for *Belitz*, at the distance of two miles.

Oct. 8*th.* I reached *Belitz* at three quarters after two in the morning; and an hour afterwards I set out for *Potsdam*, two miles distant.

838. In my account of the former part of this journey, I have mentioned a remarkable kind of stone with which the road from *Potsdam* to *Berlin* is gravelled as far as the half-way house, two miles distant from the former place; but I shall here describe it more particularly, because of a consideration which has been presented by M. de Saussure, § 1101 of his *Voyages dans les Alpes*, and to which I have already had occasion to refer in my *Travels in England.*

839. In this passage, M. de Saussure introduces a mineralogist studying the phenomena of the country which lies between the *Jura* and the *Alps*,

and particularly observing the masses of *primordial stones* scattered over the surface of this tract; afterwards, speaking of the western bank of the *Lake of Geneva*, he thus continues: "He will behold with "some interest large *blocks* of these *débris* dispersed "here and there on the borders of the *lake*; for "example, between *Allamand* and *Rolle*. There "were formerly very fine ones along the high road; "but they have been almost all destroyed, either "for the purpose of mending that road, or for "building. It was very natural that such uses "should be made of them; but for me, I cannot "see, without a lively regret, the destruction of "such precious *monuments* of the *great revolution* "*to which the surface of our globe is indebted for* "*its present state*. For if this destruction conti-"nues to make such progress as I have seen during "the last twenty-five years; if the *enclosure of* "*lands* and the construction of *buildings* go on in-"creasing in the same proportion; it is probable "that, in the course of two or three centuries, few "or none of these *monuments* will be left in our "country. This consideration combines with many "others in proving the truth of an opinion, which "I have elsewhere already hinted; that although "the mountains, especially the primitive, appear "to be of such an antiquity as alarms the imagi-"nation, yet the *actual state* of the *surface of our* "*land*, its *population*, its *culture*, are comparatively "of an *almost recent date*."

840. When I cited this passage in my *Travels in England*, it was with reference to a tract of country in which M. de Saussure's prediction has been completely fulfilled; and that within a much shorter period of time than will be the case in the neighbourhood of *Geneva*. On my arrival in *England*, near 40 years ago, happening to go the first year to *Bath*, I saw the hills near *Marlborough* in *Wiltshire* covered with large *blocks* of *granulated quartz*. This was a very remarkable *monument* of the nature of the *great revolutions to which the surface of our globe is indebted for its present state*. It was a phenomenon proceeding from the same cause as the dispersion of the *blocks* in the neighbourhood of *Geneva;* but the latter blocks consist of the same *genera* of stones which compose the central chain of the *Alps;* and hence M. de Saussure had supposed them to have been brought down from those mountains by what he called the *débacle*, that is to say, the retreat of the *sea* from our *continents*. He had however remarked one circumstance, which, if he had extended his observations farther, would probably have induced him to change his opinion: this circumstance was, that, among the *blocks* scattered around the *Alps*, and even in the vallies of that chain, some are of stones not known to exist in *strata* in any part of the chain itself. But he could not have fallen into the same error with respect to the phenomenon of *Marlborough downs*, which concurs with many others described in the course of the present Travels in proving, beyond all possiblity

of doubt, that the *masses of stones* scattered over our continents have not *migrated* on their surface from any place whatever. The *blocks* of *granulated quartz* which I observed on those downs in such great abundance, soon after my arrival in this country, were not only scattered on hills composed of *chalky strata*, but no *stratum* of their own kind is known to exist throughout the whole of the southern part of *England;* thus no cause acting superficially could have conveyed them thither. But, that I may return to M. de Saussure's remark; having passed very frequently, in the course of 30 years, over the hills near *Marlborough*, I saw the blocks there gradually diminish in quantity, till at last, in consequence of the extension of *agriculture*, and the *uses* made of their fragments in the construction of walls and pavements, and the gravelling of the road, they rapidly and entirely disappeared.

841. It will require a longer time to produce the same effect with respect to the *blocks* in the neighbourhood of *Potsdam.* Within the space of two miles from that place, on the road leading to *Berlin*, I passed over two ridges of hills strewed with these *blocks*, which extend into *Brandenburg;* but I have never found them anywhere else, nor have I seen *strata* of the same species in any mountain. This stone, as I have already said, is extremely remarkable, being composed of very black *hornblende*, and *feldspar* of a most lively red; and these colours are everywhere in contact with each

other,

other, not being separated by any intermediate shades. The *blocks* are laid along the sides of the road, which, very much frequented by carriages, because the King has a palace at *Potsdam*, is constantly requiring to be repaired with fresh fragments of this stone. To this tract, therefore, M. de Saussure's remark respecting the space which he had observed near the *Lake of Geneva* may exactly be applied; since it is very probable *that, in the course of two or three centuries, none of these blocks will be left* upon the hills near *Potsdam*; and, as they are scattered over so limited a space, they may even, within that period, be all cleared away and forgotten.

842. I was indebted to a favourable circumstance for seeing these stones to the greatest advantage. The blocks having been split on the hills, in order to render the carriage more easy, large fragments lay in heaps on the sides of the road, ready to be broken small when it required mending; and the fine colours of these had been brought out by a heavy shower which had just fallen. I never observed so beautiful an assemblage of stones in any other spot, except near the *Lizard-point*, where, as I have related in my *Travels in England*, I saw to the same advantage, after rain, the *serpentine* of that cape, with its spots of red, black, and green, not merely in the blocks and fragments scattered over the adjacent grounds, but in the large pyramids rising on the coast, which exhibited these colours in all their brilliancy.

843. All the *blocks* of these *Potsdam* hills present the same association of very black *hornblende*, and *feldspar* of a lively red; but there is much variety in the relative proportions and distribution of these substances. In some of the masses, the ground was *black*, with large *red* spots; in others, the spots were *black* and the ground *red.* A great many pieces were speckled with *red* on a *black* ground, and others with *black* on a *red* ground; the spots in all differing very much both in form and in arrangement; there were even some masses in which the *red* and the *black* formed distinct stripes, alternating with each other, as if in strata. In short, the skins of the leopard and the zebra are not more admirable, with respect to either the disposition or the beauty of their colours. It would be worth while to saw off and polish specimens of all these varieties, and to lay them up in some public cabinet; for, as I have already said, their source, in time, will certainly be exhausted.

844. I arrived at *Berlin* at 11 in the morning, having employed 30 days in this journey, upon which I had set out on the eighth of September, 1799. I continued for some time after this to reside at *Berlin*, and subsequently at *Brunswick;* till in July, 1804, I undertook the Travels which have been already published, passing that year along some parts of the coast of the *Baltic* and of the *North Sea*, and employing the following years in various excursions in *England.*

CONCLUSION.

SUCH and so numerous are the monuments of every kind, belonging to the History of the Earth, which I have observed in my various Travels; and I was already in possession of this abundance of materials, never before collected under one point of view, when I wrote and published my *Elementary Treatise of Geology*, engaging myself to establish on indubitable facts all the propositions contained in that work. Of all sciences founded on *facts*, *geology* comprizes within it the greatest number of classes, which are all required to concur in its conclusions; and since it has been directed to the elucidation of the *history* of the *past ages* of the *Earth*, and consequently of that of its *inhabitants*, it has become of the highest importance to the whole human race.

This science having sprung up precisely at the time when I was engaged in my earliest studies, it greatly attracted my attention, and I soon became fully sensible of its importance. Hence I was led to a careful examination of the systems already in general circulation; and on considering their foundations, I was not slow to perceive, from my acquaintance with the mountains in the neighbourhood of which I then resided, that these systems were premature, a sufficient number of facts not having been as yet collected to admit of the deduction of solid conclusions; and I therefore resolved that I would myself undertake a course of regular observations. Accordingly I have had this object constantly in view, in the whole series of my Travels from the year 1754, beginning with my excursions among the mountains, when I was engaged in experiments on the measurement of *heights* by the *Barometer*, and on the *heat* of *boiling water* at different levels; and it may appear how much time and labour I have employed, both in studying terrestrial phenomena at various elevations, and in different parts of our continent very remote from each other, and in following the progress of physical causes, as well general as particular.

It was not till after I had collected so great a multiplicity of facts belonging to every class essential to my object, that I wrote the fundamental work to which I have just referred: in a work of that nature, it would have been impossible to introduce these facts with all their circumstances: for they were by far too numerous, and such great intervals would thus have been interposed between the different conclusions, as would have rendered it impossible for the memory to retain the points of connexion between them. I therefore *generalized* the *facts* belonging to each class, in order to deduce from them the necessary conclusions; leaving it to my *Travels*, which I reserved for subsequent publication, to shew the accuracy of these *generalizations*, by precise descriptions of a vast abundance of *particular facts* of every class.

It has required much time, in the midst of my other occupations, to arrange and publish these numerous observations, together with all my experiments on the actions of physical causes; which is the reason that this undertaking has not been sooner completed. But now, all who are desirous to prevent the introduction of error into a science, so interesting to the whole human race, will comprehend that it would be as contrary to every principle of philosophy, on one side, to refuse to admit these conclusions, without pointing out errors either in the detailed descriptions of the phenomena, or in the deductions drawn from those descriptions, as, on the other, to oppose them merely by bringing forward other systems, not established by facts collected in a similar manner: a task which I have already shewn that those who have published such systems have been very far from executing. I shall therefore briefly state the principal propositions which result from this great assemblage of facts, in order that my readers may have a clear view of the whole.

I. Most of the errors which have been introduced into geology, and which, subverting each other in their rapid succession, have thus led to a persuasion that there is no solidity in this science, proceed from the neglect of such a study of terrestrial phenomena as might enable men to discern and distinguish two separate *periods* in the History of the Earth, one *prior*, the other *posterior*, to the birth of our *continents.*

II. These two *periods* have been determined by the discovery, now generally admitted, that the part of the globe which at present is inhabited by man, was once the *bed of the sea;* for the *first period* must evidently have been that of the continuance of the globe in this first state; and the *second* must have begun at the epoch when the bed of the ancient sea became *dry land.* This, I say, is a point on which there is no longer any controversy. But the earliest geologists who acknowledged these facts imagined several *slow* causes of a gradual *retreat* of the sea from its original *bed.* It was only, however, before the study of terrestrial phenomena had been carried to a sufficient length, that such an idea could have been conceived; for continued observations have shewn all these *slow* causes to be devoid of reality; as I proved, in my first work, by comparing them with facts; and all geologists of any distinction now consider it as a point which has been demonstrated, that the birth of our *continents* was occasioned by some *sudden revolution* of the globe.

III. But the want of discriminating between the two periods above determined, and between the phenomena separately assignable to each, has proved the source of their errors. It has been supposed that our *continents*, since they have existed as such, have been the theatre of certain operations, which, however, are now demonstrated to have taken place on the *bed of the sea;* and as this mistake has rendered it impossible to attribute these operations to any other *causes* than those known to be at present acting on the surface of the globe, (though the precise manner in which they act, and what effect they have really produced, have never been considered,) it has hence been found necessary to allow to the action of these causes a *time* without any determinable limit; because it cannot be shewn that, within a *known period*, they have produced any similar effect. Of this I shall not adduce any other example, than that of the supposed *excavation* of *vallies* by the action of *running waters;* an operation which would require a *time* absolutely illimitable, since no actual *progress* in it can possibly be pointed out.

IV. In the very first of my geological works, I refuted all these systems of *slow* operations on our continents, not only collectively, but each in particular with respect to its distinctive points, by a multiplicity of phenomena, which afford demonstrative proofs that our *continents* are of very small antiquity. De Dolomieu and de Saussure both so highly distinguished as attentive observers of nature, not only acquiesced in the proofs which I adduced of this very important circumstance in the *history of the earth*, but supported them with new ones resulting from their own observations; as I have already shewn with regard to M. de Saussure. I have always been at a loss to comprehend how those who have since persisted in maintaining systems of such operations on our *continents*, as must have required an incalculable *time*, have found it possible to preserve a strict silence respecting these proofs of their error, though an error which involves within it the whole science of geology: I can only suppose that their prejudices have diverted their attention from these proofs, because I had contented myself with stating them under the form of *general facts*; which I did under the expectation, that, as it was every where easy to verify them, the attention of others would be excited by this object; which has not yet been the case. However I have now, in my various *Travels*, demonstrated the exactness of these *generalizations*, by such an accumulation of facts of all genera and species, that it will be no longer possible to pass them over in silence. I shall therefore proceed to shew the nature of these facts, and the *geological* consequences which result from them.

V. The *causes* which are now acting on the surface and on the borders of our *continents* are all known, and the following are the circumstances common to their action. In the first place, it is easy to distinguish the points where their operation commenced, on certain parts of the continents; and hence we are enabled to determine the state of these parts, when they were abandoned by the sea, which is the leading epoch in their history. Now, in many cases, it is possible to measure the *progress* of the effects of these causes, as well in *totality*, as within known *times;* and thus, from the variety of the *causes*, we are furnished with all that multiplicity of *chronometers*, absolutely distinct, and independent of each other, which I have so particularly described in the course of my Travels, and which all concur in demonstrating the *recent origin* of our *continents.*

VI. The same course of investigation leads to another object, which is likewise of great importance in geology. Having thus ascended to the points where commenced the action of *continental causes*, that is to say, (of those causes which have acted on our continents since their birth,) we here discover what must have been produced by those different *causes*, which had been antecedently in action on the *bed of the ancient sea;* and the principal *effects* of the latter causes may be characterized as follows. The first was the production of *strata* successively differing in genera and species, all of which, from the nature of their composition, must have been formed in a *continuous* manner, over large spaces, and in a situation nearly *horizontal.* This, I say, was evidently the first effect; but afterwards, from what we now observe, these *strata* were divided by fractures into masses which became *ridges of mountains*, having undergone such great *angular movements*, that *vallies* were necessarily produced in their intervals. After so many descriptions as I have given in my Travels, I need not hesitate to assert that an attentive observation will evidently shew the impossibility of the production of *vallies* any otherwise than by this operation, which must have taken place before the birth of our *continents;* for it may be seen, in all vallies, that the only effects of *running waters* and of *gravity* have been to attack their projections, raising, at the same time, the lower parts of these original cavities of the continents, by the materials which the waters have detached from their borders and deposited on their bottom. The establishment of this point is so essential, that I have not been afraid of too greatly multiplying the proofs of it, by descriptions of *vallies* and of the effects of *running waters* at every height, among mountains, between hills, and in plains, throughout a great variety of countries. Hence those who may still think it proper to maintain that *running waters* have excavated *vallies* will no longer have any excuse for forbearing to meet these facts with something of the shape of argument;

ment; whereas they have hitherto opposed them no otherwise than by silence.

VII. We know then in what the observable mass of our *continents* consists; that is to say, in *strata,* the greater part *solid,* and the rest *soft,* which differ successively in genera and species, and which bear certain characters of having been originally deposited in a situation nearly horizontal, over large tracts of the bottom of the sea. The first question which now presents itself is the following: whence have proceeded the substances successively contributing to the formation of these *strata?* For that they must have proceeded from some part of the globe in which they had previously existed is very evident. With respect to this question there are only two systems; and I shall mention in the first place that of Dr. Hutton and some other geologists; that these substances were formerly borne along by the *rivers* of *ancient continents,* (which continents, by the continuance of this operation, were finally destroyed,) and were spread over the bottom of the ancient sea by the motion of its waters. In refutation of this opinion I have assigned a peremptory reason. The mud transported to the *sea* by *rivers* is composed of mingled particles of all the substances which those streams have detached in their course: now there does not exist in the *sea* any imaginable cause capable of *separating* these substances, and keeping them *apart* from each other, until formed into masses of distinct *strata;* as, for example, the various species of *schisti* to a great thickness: then, immediately on these, *strata* of *lime-stone*, in some places not less than 5000 feet thick, as is to be seen in their abrupt sections; and on these again, without any steps of transition, *strata* of *sand-stone*, also to a great thickness; without reckoning many other *strata* of very distinct kinds, which are intermixed with the latter. How could these substances have been *sorted*, and *separately* deposited one species on another, upon the bottom of the sea? Such a supposition is nothing less than impossible.

VIII. There remains therefore only the system which has been adopted by the geologists most distinguished by their accurate investigation of natural phenomena; I mean that of *chemical precipitations*, successively different, in a *liquid* originally covering the whole globe, in which the *elements* of the *mineral strata* and of the *fluids* that compose the *atmosphere* were held in a state of reciprocal dissolution, and of which the *liquid* of our present *sea* is the *residuum*. This is the system that I have adopted from de Saussure and de Dolomieu; for it is perfectly conformable to the *general laws* of *chemistry*, and, with the addition of another cause, it affords a complete explanation of all the phenomena of our *mineral strata* and of the *atmosphere*. Of this other cause I shall presently speak, after having remarked that the above is the only road by which we can ascend to the succession of physical events that were brought to pass on our globe by causes now no longer existing, and in which we cannot go astray, provided that we correctly ascertain every circumstance in the *facts* whereon we build, and that we confine ourselves to strictly logical *conclusions.*

IX. The additional *cause,* to which I have just alluded, will now lead me to another question necessarily involved in this deduction from terrestrial phenomena. Since all the substances which compose our *mineral strata* and the *atmosphere* were originally held in dissolution by each other in the same *liquid,* no change could have taken place in this liquid, unless certain new ingredients had combined with some of those already contained in it to form *solid molecules,* successively differing in species, which, separating from the rest of the *liquid,* had sunk, and accumulated at the bottom; while, during this operation, other ingredients, combining under the form of *expansible fluids,* had ascended to compose the *atmosphere.* For this is the manner in which all *chemical precipitations* are immediately produced. Now whence did these new ingredients proceed? Dr. Hutton, who supposed that our strata had been formed of the substances transported to the *sea* by *rivers,* did not concern himself with this question; but, on observing what a mixture of substances *rivers* carry to the *sea,* the impossibility that any imaginable cause could have *separated* these materials, and thus produced *strata* absolutely *distinct*, laid one on another, as is the case with those which everywhere compose the mass of our continents, becomes so evident, as absolutely to enforce acquiescence in the hypothesis of their formation by *chemical precipitations*. The above question must then necessarily present itself: What was the source of these new substances, by the introduction of which were produced, in the same *liquid*, these successively different *precipitations?*

X. We are here obliged to enter into a wider field of facts; for, as all terrestrial phenomena are connected with each other by some common causes, it is impossible to determine the cause of any one of them with certainty, without taking into consideration all the others which can possibly have any relation to it. Some step is wanting to enable us to ascend, from the general conclusion that our *strata* have been produced by *chemical precipitations* in a *liquid*, to the *cause* of these *precipitations*, which must necessarily have been the introduction of *new substances* into the *liquid;* and we shall find this *cause* by the solution of another question: since our *mineral strata* were certainly formed on the *bottom of the sea*, in what manner were they *abandoned by its waters*, and reduced to their *present state?*

XI. There are only two possible causes of this change on our globe; either the retreat of the *sea*

from

from its ancient *bed*, which thus became our *continents*, or the *elevation* of these *continents* above its level. Dr. Hutton determined in favour of the last of the propositions of this dilemma; in which respect he adopted the system of LAZARO MORO, without paying any attention to the peremptory argument already brought in refutation of it in my *Lettres sur l'Histoire de la Terre & de l'Homme*; an argument which I shall here repeat. The cause assigned to this *elevation* is the sudden action of a great internal *heat*. But *heat* can occasion in *solids* only an inconsiderable *expansion*, when acting on them alone; in order to *raise* them, therefore, that is to say, to effect their separation from the base on which they rest, *heat* must produce, between this base and the mass to be elevated, *expansible fluids*: the latter, when they have acquired a great density, may undoubtedly act very powerfully; but the solid mass of the strata could not be *raised* in this manner without being also *broken*; and Dr. Hutton even adduced it as a proof of this *elevation*, that our *strata*, in fact, are *broken* in innumerable places. Now since it is only so long as *expansible fluids* are confined within a space of which the sides oppose resistance to them, that they can exercise their action, their escape through these apertures, as it would have reduced their *density* to that of the atmosphere, must have deprived them of all power within. The vault then, completely shattered, would have fallen down again on the base from which it had been separated. My first geological work having been written in French, it was perhaps for that reason that Dr. Hutton was not struck with this objection; but what surprizes me is that Mr. Playfair, who, in my Letters to Dr. Hutton, published in the *Monthly Review*, must have seen this objection, (as well as that which relates to the minute particles carried by *rivers* to the *sea*, considered as the source of our *mineral strata*,) has repeated both these hypotheses, without taking any notice of my arguments against them.

XII. All the phenomena of our *mineral strata* whereon these geologists found the system of *elevation*, particularly the *ruptures* and *angular movements* which these *strata* have undergone, would equally have been effected by the *subsidence* of such parts of the surface of our globe as are now at the lowest level; so that these phenomena themselves afford no indication of the manner in which they were produced: it must certainly have been in one or the other of these two ways; either by the *elevation* of the parts now *highest*, or by the *subsidence* of those now *lowest*; this, I say, is an absolute dilemma; but as both these *causes* would have occasioned the same mechanical effects, that is to say *fractures*, and *angular motions* of the separated masses, there is nothing in these immediate effects that can determine to which of the two they should be assigned. We must therefore inquire, in the first place, whether there may not be some reason for the exclusion of one of these *causes*; and then

proceed

proceed to examine the other by a comparison with the phenomena which ought to be referable to it.

XIII. I have already shewn a peremptory reason for the exclusion of the hypothesis of *elevation;* namely, that, after the rushing out of the *expansible fluids* by the effort of which it is supposed to have been effected, the broken masses would have fallen down again on the bottom of the *caverns* produced by their separation from the base to which they had originally been united. Now as this hypothesis has not even for its object the explanation of the actual state of our *strata,* but was imagined principally for the purpose of accounting for the *existence* of the *continents* above the *level of the sea,* it must manifestly require that the *fractures* and *dislocations,* which are now observable in our *strata,* should have been suffered by them during the very elevation of these *continents;* whereas the impossibility that any *continents* should have existed from this cause has been proved by the preceding argument: they do, in fact, exist only from the *subsidence* of a part of the surface of the globe, and the consequent retreat of the sea from its *ancient bed,* which had already been the theatre of the catastrophes whereby our *strata* were reduced to their present state. Now to this latter hypothesis it is not possible to apply the same peremptory objection which I have adduced against that of *elevation;* namely, that the masses when elevated would have *fallen* down again, and that thus no *permanent* effect could have been produced; *permanence* being, on the contrary, the necessary consequence of the *subsidence* itself. In the former system, the *elevation* would have been attended with the formation of *caverns*, over which the *continents* must have remained suspended without any support; a thing altogether impossible: in that of the *subsidences*, (supposed to have been only partial,) the masses, *subsiding* in *caverns* previously existing beneath them, must, when they reached the bottom, have remained there in a state of stability; except in the case of some effects which have been produced on our *continents* since their birth, and have contributed to shew the cause of the state of our *strata*, namely, new *subsidences* of some parts of their surface, (of which I have given examples in the course of my Travels;) while, at the same time, *earthquakes* are an indication of the vacancies still remaining between the masses which have subsided in the caverns, and which it is evident must rest on their bottom, because these shocks produce externally so little effect. This is an absolute difference, totally excluding the system of *elevation*, but in no respect contrary to that of *partial subsidences*.

XIV. But besides, the consequences of the latter system supply us with direct arguments in its favour; the first of these consequences is that it leads us to the essential *cause* which was left in suspence above, that of the introduction of new substances into the

primor-

primordial liquid, and of the consequent production of *precipitations* successively differing from each other; which I have shewn to be the only origin that can be assigned to our *mineral strata*. My present aim being only to give a summary view of the great objects of geology, I cannot here enter into the whole of my system with respect to this point; but I have stated it fully in my *Elementary Treatise of Geology;* so that nothing farther is at present necessary than to explain briefly its fundamental points, and to indicate the direct proofs by which, in that work, I have supported it.

XV. Our globe was originally composed of disunited *particles*, on which were formed, in the first place, *strata* of *granite*, and others of the same class. These *strata*, resting on a base so little solid, underwent repeated fractures, and the *liquid* that covered the globe passed through these apertures into its interior parts, thus causing the subsidence of the *particles*, and producing the *caverns*, which, by degrees, increased in extent, and became deeper, till at last they occasioned the catastrophes of the different classes of *strata* which had been formed by successive *precipitations* in the *liquid*, from the following cause.

XVI. The *liquid*, introducing itself among these *particles*, and combining with them, formed *expansible fluids*, which, ascending through the same *fractures* of the *strata*, occasioned, in the *exterior* part of the *liquid*, *precipitations*, successively *differing* in their nature, because the loss of the substances which entered into the composition of certain classes of *strata* effected changes in the *liquid* itself; and these changes were attended with correspondent differences in the *expansible fluids* formed by that portion of it, which, at each new catastrophe, penetrated into the interior part of the globe.

XVII. Another effect of this introduction of the *liquid* among the interior particles was that of producing the *concretion* of large masses, which formed in the *caverns* a kind of partition-walls, and served as props to the *strata*, till these masses themselves sunk, in consequence of the penetration of the liquid beneath them. On this account, the later catastrophes were much more considerable than the earlier, which had been occasioned only by partial *caverns*; and it was not until after the *subsidence* of these concrete masses that stability was produced. In this manner an anterior *continent* was, for a long time, supported, till at last, by its sudden *subsidence*, as I have explained in my former works, the *bed of the sea* was changed. Such is the general progress of causes and effects whereby our *continents* have been brought into their present state; and I shall now give an equally concise view of the phenomena which afford indubitable proofs of this succession of events.

XVIII. The first immediate proof consists in the changes which certain circumstances observed in our *strata* shew to have taken place at sundry epochs in the *liquid* of the sea, and in the *atmosphere.* Within a certain period, was formed a class of *strata* distinguished by the title of *primordial,* which exhibit no trace of the existence of *organized beings* on our globe, either in the *sea* or on the *land.* Another class of *strata,* called *secondary,* was afterwards produced, and in general, these strata were very different in their nature from those which had preceded them. It is in this new class of *strata* that we find the remains of *organized bodies,* in the first place, of *marine* animals, and above these, of vegetables and *terrestrial* animals. In the succession of these *strata,* we find successive changes in the *species* of the *organized bodies,* following those which I have already shewn to have taken place in the *water* and the *air.* Nothing then, can more exactly indicate the whole progress of the *chemical* operations which I have traced above, and of which I shall now explain the connexion with these new facts.

XIX. While every catastrophe of the *strata,* occasioned by *subsidence,* was attended with the ascent of *expansible fluids* from the interior parts of the globe, into the *liquid* where they produced the *precipitation* of some of our *mineral strata,* there were disengaged from the same *liquid,* other *fluids,* which combined to form the *atmosphere.*

During the first period of these operations, neither the *liquid* nor the *atmosphere* was in a state proper for the existence of *organized beings;* afterwards, when such things did exist, changes in those which belonged to both the classes, marine and terrestrial, were produced by corresponding changes in the two *elements*, water and air; it being by the latter element that terrestrial animals and vegetables were effected. Such is the general connexion between the formation of the *strata*, and the history of *organized bodies* on our globe; and a direct proof that these two classes of changes, thus reciprocally dependent on each other, originated in successive subsidences of different parts of the *bed of the sea*, is afforded by this circumstance; that all *precipitations* in the marine liquid, and all perceptible *changes* in *organized creatures*, have been terminated by the great revolution, which changed the *bed of the sea*, and thus brought the surface of our globe into its present state of *stability*.

XX. It may now be understood by what motive I have been led to extend my observations relative to the masses of different kinds of *stones* scattered over soils to which they are extraneous, into so many various countries and situations; this being a phenomenon so intimately connected with the *catastrophes* of our *strata*. There are only two possible modes of explaining the *dispersion* of these *masses;* either they have *migrated* from the eminences, over the low grounds, in consequence of the action of some impulsive cause, or they have been *ejected* from within, in the very spots where we at present find them, by the *expansible fluids* violently compressed in those *caverns* into which *subsided* the enormous masses of *strata* now lost from the surface. But, after the multiplicity of direct facts collected in my Travels against every possible idea of the *migration* of these *masses* on the continents, there can remain only the other proposition of the dilemma, which I have moreover established by facts equally direct and equally numerous; namely, that they have been ejected from within. And thus the whole of my system is here again supported on a phenomenon almost universally prevalent over every part of the surface of our continents.

It were unnecessary to state in this place the perfect correspondence which subsists between the general result of these facts, and the *History of the Earth* as contained in the Book of Genesis; but in my *Letters to Professor Blumenbach*, this correspondence has been fully pointed out. Of all *geological* conclusions, this is unquestionably the most important, since it concerns the whole human race; but neither in the above letters, nor in those *sur l'Histoire de la Terre & de l'Homme*, have I placed it among the proofs of my system; I have explained it for the purpose of fixing more strongly the attention of my readers; but I have never recurred to it for the support either of the *facts* which I have brought forward, or of the *conclusions* which I have deduced from these facts; for this would have been a *petitio principii.* On this great point, Truth has been my leading object; and as I have sought it by an attentive study of *terrestrial phenomena,* so I believe that these Travels collectively will be found to contain it.

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TABLE

OF THE

GEOLOGICAL FACTS

Described in these Travels, *arranged as belonging to the* Two Periods *of the* History of the Earth, *which are distinguished in the* Coclusion; *with References to the Volumes and Sections.*

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First Period *,

During which our *Continents* were formed at the bottom of the *ancient sea*, and underwent there various *catastrophes.*

I.

The *strata*, having been produced by *precipitation* in a *liquid*, were originally *horizontal* and *continuous.*

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* Under this *First Period*, it is here intended to comprize the *Six Periods* or *Days* of the *Creation*, as recorded in the book of Genesis, together with the space of time, beginning from the creation of man, and terminating in the deluge; which last space is considered as forming the commencement of the *seventh day.* In Mr. Parkinson's very interesting work on the *Organic Remains of a former World*, it may be seen, p. 451, Vol. III. that the diligent study of nature has led that gentleman to form the same conclusions respecting the *length* of these *days.*

For.

Formation of the *strata* by *precipitation*, and consequently in a *horizontal* position, first determined by M. de Saussure from his observations on the *breccias* of the *Valorsine*, §§ 12—16, I.

Their original *horizontality* and *continuity* proved also by the *marine* and other *organic bodies* contained in them, §§ 363, 415, 431. I. §§ 462, 470, 579, 676, 786 *a*, II.

Strata of *sand-stone* at *Zittau* once continuous with those on the borders of the *Elbe*, § 483, II.

That the *consolidation* of the *strata* on the bottom of the sea did not require a great heat, shewn by the consolidation of *tofus* on the bed of the *Wiesent*, § 663, II.

II.

The undermost substance in the known mass of our continents is *granite*, which, contrary to the opinion of some mineralogists, was formed, like the rest, in *strata*.

Stratification of granite apparent

In an insulated rock near *Darmstadt*, § 238, I.
In the form of the hill of *Drackenfeld*, § 24 , I.
In the *Rosse-trap*, a granitic hill encompassed by strata of wacke, § 386, I.
In a quarry near *Herrnhutte*, § 482, II.
In the sides of the valley of the *Queis*, § 494, II.
In Mount *Kynast*, § 503, II.
In rocks in the *Giant's mountains* which appear as if composed of piles of blocks, §§ 510, 517, 551, 552, II.
In the *Ochsen-kopf*, § 700, II.
In blocks on the *Fichtelberg*, § 712, II.
In the *Rollen-stein*, § 714, II.
In the *Luchsberg*, §§ 719, 721, II.

In *blocks* near *Egra*, § 733, II.
In eminences near *Carlsbad*, § § 741, 746, 750. II.
In hills near the *Elbe*, § § 812, 815, II.
Bed of the *Zackel* formed by the planes of *granitic strata*, § § 506, 509, 539, II.
Strata of two distinct *species* of *granite* in the *Grosse-rad*, § § 524, 525, II.
——————————— in the *Friesen-stein*, § 549, II.

III.

The *strata* which were formed on the *granite* differed successively from each other, and no remains of *organic bodies* are found, either in the *granite* itself, or in the first of the succeeding *strata;* but in those of later production, various kinds of these bodies are contained.
granite covered with *gneiss* on the summit of the *Schnee-koppe*, § 531, II.
——————————— in *Mount Helicon* near the *Welt-ende*, § 559, II.
——————————— in the *Ertz-gebürge*, § 768, II.
Successive hills of *granite*, *gneiss*, and *schistus*, in the country of *Bayreuth* towards the *Fichtelberg*, § 631, II.
Strata of *gneiss* and of *white quartz* near *Freyberg*, § 450, I.
Gradations from *gneiss* to *schistus* in the *Fichtelberg*, § 695, II.
Gneiss covered with *porphyric schistus* near *Bilin*, § 766, II.
Great variety of strata in hills at the same level in the valley of *Tharand*, § § 426—431, I.
Strata of a fibrous *schistus* intersected with veins of *white quartz* at *Zierenberg*, § 233, I.
Schistus covered with *lime-stone*, near the *Hartz*, § § 171, 172, 351, I.
——— on the banks of the *Elbe*, where it was originally covered with a *sand stone* containing *marine bodies*, though both are now at the same level, § 786 a II.

Strata of *sand* containing many *marine bodies*, and covered with *calcareous* strata converted into *petro-silex;* near *Aix-la Chapelle*, §§ 255—258, I.

——— of *gypsum* in a hill near *Osterode*, covered on one side with *lime-stone* containing *marine bodies*, and on the summit with *marl* and *sand* in which *rhinoceros's bones* have been found, § 354, I.

Ancient *lavas*, near *Göttingen*, covered with strata of *lime-stone* and *sand-stone*, § 193, I.

Bed of *surturbrandt*, (or *fossil peat*,) in the *Cattenbül* near *Munden*, covered with strata of *white clay* and *sand*, §§ 198, 199, 201, I.

————— in the *Meisner* in the country of *Hesse*, lying on strata of *lime-stone* and *sand-stone*, and covered with others of *white clay*, *lime-stone*, and *basalts*, §§ 211, 212, I.

————— in the *Robelsberg*, covered with thin strata of *sand-stone* and *basalts*, §§ 217, 218, I.

————— near *Helmsted*, lying on *aluminous clay*, and covered with common *clay* and *sand*, § 370, I.

Alternations of *lime-stone* and *marl* in the *Jura*, §§ 52—57, 64, 82, 85, 89, 90, 115, 116, 132, 136, I.

Marine bodies found in both, §§ 31, 54, 64, 66, 82, 85, 115—117, 136, I.

Differences of the *marine bodies* in successive *strata*, near *Valangin*, §§ 93, 94, I.

Strata of *lime-stone* containing masses of *jaspachates*, in the valley of *Tharand*, § 428, I.

Marine bodies contained in the *lime-stone* of the caverns near *Muggendorf*, § 656, II.

Lime-stone covered with strata of *breccia* and *sand-stone* in the hills and plains between the *Alps* and the *Jura*, § 138, I.

Coal-bed, in a hill near *Rehburg*, covered with strata of *sand-stone* containing both *marine* and *vegetable bodies*, § 338, I.

Three *coal-beds* in a hill at *Osterwald*, of which the uppermost is mere *fossil peat*, and which are separated from each other by a succession of different kinds of *strata* all containing *marine bodies*, § 360, I.

Strata of *sand-stone* which have slidden down from those of *lime-stone*, in the valley of the *Red Mayn*, and are now covered with *gypsum*, § 691, II.
Marine bodies contained in *sand-stone* near *Pirna*, §§ 462, 468, II.
———————— near the *Bober*, §§ 579—581, II.
Strata of *sand-stone*, at *Tharand*, containing *marine bodies*, and covered with *sand*, mixed with *flints* in which also *marine bodies* are found, § 431, I.
Argillaceous strata containing *marine bodies*, and covered with strata of *sand*, near *Zell*, § 160, I.
Strata of *sand*, one of which contains abundance of *marine bivalves*, near *Aix-la-Chapelle*, § 259, I.
Vegetables in strata of *sand-stone* and *marine bodies* in a stratum containing *iron*, between *marble-strata*, in the *Hartz*, § 380, I.
Flints in the *sand*, near *Osnaburg*, which contain *marine bodies*, and must evidently have been formed in strata of *chalk* dissolved on the bed of the *ancient sea*, §§ 155, 158, I.

IV.

Phenomena of *Breccias*.

Breccias of the *Valorsine* observed by M. de Saussure, §§ 14, 15, I.
Strata of *breccia* between the *Alps* and the *Jura*, § 138, I.
———————— in the valley of *Tharand*, § 429, I.
———————— of *Walterdorf*, § 581, II.
Masses of *breccia*, in *Hesse*, containing the same primordial gravel which is found in the sand there, §§ 228, 230, 231, I.
The same circumstance in *Bohemia*, §§ 734, 735, 754, II.

V.

The latest *precipitation* in the *ancient sea* was pure *quartzeous sand,* which is spread over all the preceding kinds of *strata.*

* *Strata of this Sand described*

Near *Dasseldorf,* § 151, I.
Near *Darmstadt,* § § 235, 238, 240, I.
In the country of *Bremen,* § § 283, 285—287, I.
Near *Lunenburg,* § 322, I.
In the country of *Hanover,* § § 332—334, 339, 341, 343, I.
On *lime-stone* and *sand-stone* near the *Hartz,* § § 345, 388, I.
———————— near *Brunswick,* § 368, I.
In *Brandenburg,* § § 408, 414, 421—423, § § 595, 597, 599, 601, 602, II.
On *granite* near *Herrnhutte,* § 478, II.
In *Silesia,* § § 583, 585, 587, II.
On *sand-stone* near *Buntzlau,* § 584, II.
On certain eminences in the *Fichtelberg,* § 717, II.

* * *That these strata must have participated in the latest catastrophes of the stony strata appears*

Near *Boitzenburg,* § 311, I.
In a cliff bordering the *Havel,* § 601, II.
In a *granitic* hill of which the summit is covered with this sand, at *Meissen,* § 809, II.

* * * *Exemplification of the difference*

Between this *sand,* and that *consolidated* in *strata* on which it lies, near *Zell,* § 159, I.

Between this *sand* and the *sand* produced from *triturated granite* on the bed of the *Bober*, § 589, II.

In the course of the period during which the *strata* were formed, they underwent many *catastrophes;* (i. e. *ruptures*, attended with the *partial subsidence* of the *intermediary masses* and the *angular motion* of those which remained at the highest level; and thus became the *ridges* of *hills* and *mountains* now existing on our continents. These *catastrophes*, which determined the present form of the surface of the earth, were occcasioned by *caverns*, produced under the *strata*, in consequence of the gradual penetration of the water of the sea among the *pulverulent particles* originally composing the mass of the globe.

External proofs of the catastrophes of the strata, VI—VIII.

VI.

That *vallies, combes*, and simple *clefts*, have resulted from these *catastrophes*, and not from the action of *running waters*, is evidently shewn by their various phenomena.

* *The opposite sides of vallies composed of different substances.*

Valley of *Grund* bordered with *schistus* on one side, and *gypsum* on the other, § 353, I.

Narrow valley of the *Bode*, with *wacke* on one side, and the *granitic* obelisk of the *Rosse-trap* on the other, § 384, I.

Vale near *Ilsenburg*, with *marl-stone* on one side, and *schistus* on the other, § 391, I.

Valley of *Tharand*, with *porphyry* on one side, and *gneiss* on the other, § 430, I.

Banks

Banks of the *Bober* composed of different kinds of *granite*, § 571, II.
Combe near the *Bober*, with *granite* on one side, and *gneiss* and *schistus* on the other, § 573, II.

** *Different inclinations of the strata on the opposite sides of vallies.*

On the banks of the *Leine*, §§ 169, 191, I.
———— of the *Sieber*, § 188, I.
On the sides of a combe near *Hof*, § 629, II.
——— ——— of a cleft at the foot of the *Biliner-stein*, § 766, II.

*** *Differences in the height and form of the opposite sides of vallies.*

Of the opposite banks of the *Seyon*, § 86, I.
———————— of the *Doux*, § 105, I.
———————— of the *Weser*, §§ 163, 366, I.
———————— of the *Elbe*, 403, 469, I. §§ 783, 793, 802, 804, 806, 808, 813, 816, 818, II.
———————— of the *Bober*, §§ 555, 557, 558, II.
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———————— of the fracture from the bottom of which the *Rosse-trap*, §§ 383, 384, I.

**** *Differences of declivity in the same valley.*

In the bed of the *Kemnitz*, §§ 499, 572, II.
In the valley of the *White Mayn*, § 638, II.
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Shewn by a *cascade* on the course of the *Doux*, § 69, I.
———————————— of the *Reuse*, § 83, I.
———————————— of the *Suze*, § 126, I.
———————————— of the *Bode*, § 383, I.
———————————— of a brook at *Raden*, §§ 472, 473, II.
———————————— of the *Kockel*, §§ 512, 513, II.

Shewn

Shewn by a *cascade* on the course of the *Elbe*, § § 535, 536, II.
——— by masses of strata forming *bars* across the course of the *Bober*, § § 566, 579, II.

* * * * * *Cavities and large horizontal spaces on the course of streams; the former producing Lakes and Pools, and the latter being inundated when the streams are swelled.*

Lake on the course of the *Doux*, § § 67, 68, I.
Lakes of *Neufchatel* and *Bienne*, § § 130, 133, I.
Lake near *Lockum*, § 339, I.
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——————— of the *Havel*, § § 407, 409, I. § § 598, 601.
Pools on the courses of the rivers descending from the *Giant's mountains*, § § 498, 543, 547, 553, II.
——————— of the principal branches of the *Mayn*, § 642, II.
——————— of the other streams proceeding from the *Fichtelberg*, § 725, II.
Horizontal spaces on the course of the *Ecker* and the *Ocker*, § § 397, 398, I.
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——————————— of the *Elbe*, § § 604, 694, 813, 815, 820, 827, 834, II.
——————————— of the *Elster*, § 619, II.
——————————— of the waters of the valley of *Berneck*, § 638, II.
——————————— of the *Wiesent*, § § 653, 679, II.
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———— of the *Suze*, § § 118, 119, 123—126, 128, 129, I.
———— of the *Leine*, § 344, I.
———— of the *Ocker*, § 398, I.
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———— of the *Bober*, § § 555, 561, 562, 564, 565, 568—577, 582, II.
———— of the *White Mayn*, § § 637, 638, II.
———— of the *Wiesent*, § § 653, 659, 662, 675, 680, 681, II.
———— of the *Eger*, § § 735—737, 741, 742, II.
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* * * * * * * *Various marks of fractures and subsidences.*

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In the valley of the *Leine*, § § 191, 344, 345, I.
In a valley near *Cassel*, § § 220, 221, I.
In the valley of the *Rhine*, § § 243, 247, I.
In a vale near *Rheburg*, § 339, I.
In vallies in the *Hartz*, § § 348—350, 380, 383—386, 395, I.
In the valley of the *Mulda*, § 438, I.
In valleys and combes near *Maxen*, § § 454, 455, 457, 458, II.
In a deep combe forming a low forest near the *Elbe*, § § 608, 609, II.
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———— of the *Red Mayn*, § § 685, 691, II.
———— of *Carlsbad*, § § 741, 746, II.
In a combe near *Brix*, § § 761, 762, II.

Impos.

******** *Impossibility that Combes can have been formed by the small quantities of water which flow in them, shewn*

In a combe in the *Jura*, § § 25—27, I.
In combes in the *Giant's mountains*, § § 514, 516, 533, II.
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********* *Clefts and Fractures in the strata, attended with various accidents.*

La *Roche-fendue*, §§ 70—72, I.
Cleft affording passage to the *Seyon*, §§ 91, 136, I.
Clefts in the rocks which border the *Val-St.-Imier*, § 121, I.
—— affording passage to the *Surze*, §§ 123, 125, 126, 128, 129, I.
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Cleft in the hills near *Muggendorf*, §§ 664, 672, 673, II.
—— affording passage to a brook near *Töpliz*, § 770, II.
Fracture of the strata in *Freyberg*, which forms the boundary of the district of the mines, § 451, I.

VII.

The *mountains* and *hills* of the present continents are formed by the masses of various kinds of *strata*, which were left by the *catastrophes* at a higher level than the rest.

* *State of the abrupt sides of our present eminences, shewing them to have become such by the subsidence of masses of strata originally continuous with those which compose them.*

Abrupt sides of the mountains encompassing a low space in the *Jura*, near the entrance of that chain from *Franche-Comté*, § 23, I.

—————— of the *Creux-du-Vent*, § 50, I.

—————— of *Mont Salève*, § 135, I.

—————— of the hill at *Osterwald*, § 359, I.

—————— of the *Regenstein*, § 388, I.

—————— of hills near *Löbau*, § 477, II.

—————— of the *Schnee-grübe*, §§ 520—522, II.

—————— of the *Mole*, § 523, II.

—————— of granitic eminences above *Carlsbad*, §§ 741, 748, II.

—————— of the *Ertz-gebürge*, § 768, II.

—————— of eminences near the *Elbe*, §§ 787, 791, II.

** *The strata, now composing the summits of many eminences, originally covered by other strata which have slipped down on the sides.*

Granitic pyramid of the *Rosse-trap* left uncovered by the *fracture* and *subsidence* of strata of *grey wacke*, §§ 381—386, I.

Granitic chain of the *Giant's mountains* bordered on both sides with ridges of *micaceous schistus* and *quartz*, §§ 488, 494, II.

—————— of the *Fichtelberg* bordered with ridges of *schistus* and *gneiss*, §§ 694—696, 705, 717, II.

Schistose chain at *Zierenberg* left uncovered by the slipping down of strata of *lime-stone* and *sand-stone*, § 231, I.

The *Hope-warte* composed of strata of *lime-stone*, which by the slipping down of those of *sand-stone*, are left uncovered on the summit, § 226, I.

*** *The*

*** *The same strata which form the summits of eminences found near them at a lower level.*

The same *calcareous strata* which form the *summits* of the *Jura* compose also the *hills* and *plains* of *Francke-Comté* and *Burgundy*, §§ 23, 141, 144—146, I.
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Masses of *lime-stone* and *marl*, which, having been broken off from the *strata* of the *Jura*, have separated in their fall, slipping down one over another, and now rest against the foot of the chain, §§ 54—57, 88—90, 130—132, I.
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Mounts near *Ilsenburg* composed of the same *strata* as a neighbouring hill, § 391, I.
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**** *Various kinds of strata now found at the same level with which they originally covered.*

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———————— near *Pyrmont*, § 164, I.
———————— of *schistus* and *lime-stone* on the borders of the *Hartz*, § 173, I.
———————— of *lime-stone* and *sand-stone* near *Göttingen*, §§ 190, 191, I.
———————— in *Hesse*, §§ 195, 202, 208, I.
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Intermixture

Intermixture of hills and rocks of *gneiss*, *sienite*, and *porphyry* near *Dresden*, §§ 424, 426, 427, I.

———————— of *granite* and *sand-stone*, near the *Elbe*, § 475, II.

———————— of *granite*, *gneiss*, *schistus*, and *basalts*, near *Hernhutte*, §§ 481—483, II.

———————— of *granite* and *basalts*, near the foot of the *Giant's mountains*, §§ 500, 503, II.

———————— of *lime-stone* and *sand-stone*, in the country of *Bayreuth*, §§ 640, 641, 646, 652, 653, 682, 683, 686, II.

———————— of *schistose* and *basaltic* cones, near *Bilin*, §§ 764—766, II.

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***** *Similarity in the forms of contiguous hills, shewing them to have been produced by the same catastrophes.*

Hills abrupt on one side, and on the other descending in a gentle slope, in the country of *Hanover*, § 190, I.

————————————————————
———— in *Hesse*, § 208, I.

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Angular ridges and pyramids bordering the *Elbe*, §§ 464, 468, 470, 474, 782—784, 787, 791, 795, 796, 806, 813, II.

Pyramidal eminences at the foot of the *Giant's mountains*, §§ 500, 503, II.

Granitic cones in the *Fichtelberg*, §§ 709, 711, 784, 718—720, II.

****** *Irregular subsidence of the fractured masses, now found at various levels, shewn by rocks and other inequalities of the surface.*

Uneven surface of the *plain* between *Dole* and *Dijon*, § 145, I.
—————— of a sandy *hill* near *Lunenburg*, § 321, I.
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Cavities in the slope of the *Schnee-Koppe*, which receive the waters of the mountain, and thus have become lakes, § 529, II.
Rocks on the slopes of the *Giant's mountains*, § 550, II.
Calcareous rocks at *Sans-pareil*, §§ 647, 648, 649 *a*, 650, II.
Pyramidal rocks on the summit of the *Biliner-stein*, § 765, II.

The mode in which *mountains* and *vallies* were produced, exemplified by the phenomena of *ice* in the *Elbe*, §§ 303, 304, I.

VIII.

The *strata*, during their subsidences, assumed various degrees of *inclination*.

* *Sections*

* *Sections of strata variously inclined.*

In the *Jura*, §§ 23, 28, 35, 50, 54, 56, 58, 65, 83, 86, 105, 121, 123, 125, 126, 128, 140, I.
In the plains of *Franche-Comté* and *Burgundy*, §§ 141, 145, I.
In the *Deister* and other hills near *Hanover*, § 162, I.
In *lime-stone* and *sand-stone* hills near *Pyrmont*, § 164, I.
In the *Hartz*, §§ 173, 349, 383, 384, 386, I.
In the country of *Hesse*, §§ 202, 208, 220, 221, I.
Near *Aix-la-Chapelle*, §§ 259, 260, I.
Near *Boitzenburg*, § 311, I.
In the hills of *Rudersdorf*, §§ 415, 416, I.
In hills near *Dresden*, §§ 424, 426, 429, I.
In the sides of the valley of the *Mulda*, § 438, I.
In rocks near the *Elbe*, §§ 461, 462, 787, 789, 815, II.
In the hill of *Herrnhutte*, § 482, II.
In the *Dreslerberg*, § 488, II.
In a cliff bordering the *Havel*, § 601, II.
In the sides of vallies and combes in *Saxony*, §§ 615, 620, 623, 624, II.
In the *Fichtelberg*, §§ 693, 695, II.
In the *Cammer-hügel*, § 731, II.
In the valley of the *Töpel*, §§ 746—748, II.
In a hill near *Carlsbad*, § 750, II.
In the side of a combe near the *Eger*, § 759, II.

** *Edges of dipping strata appearing on the summits of hills.*

Forming ridges across an eminence in the *Jura*, §§ 58 *a*, 59, I.
——— across hills near the *Hartz*, §§ 377, 387, 388, I.
——— across the *Grosse-rad*, §§ 524, 525, II.
Split at the top into many laminæ, on a hill near *Osterwald*, § 359, I.
——— into angular columns, on the *Rollen-stein*, § 714, II.
——— into pyramids on the *Biliner-stein*, § 766, II.

Internal proofs of the catastrophes of the strata, IX—XIII.

IX.

Phenomena of *Veins.*

* *Metallic Veins.*

Vein of *lead* and *silver* in the *Hartz*, in which is a cavity forming a grotto of singular beauty, §§ 182—187, I.
Veins cut through by the fractures which, being attended with the subsidence of the intermediary mass, produced the valley of *Wildeman*, § 348, I.
General phenomena of the *mines* of *Freyberg*, §§ 432—449, I.
Proofs that the *veins* in those mines were produced at successive periods, §§ 435, 436, 449, I.
——— that they were formed by precipitations against the sides of the fissures which contain them, § 439, I.
Veins of *quartz* containing *gold*, at *Gold-cronach*, § 692, II.
Vein of *antimony*, at *Gold-cronach*, § 693, II.
False veins, in the *Hartz*, of later formation than the *true*, § 173, I.
Differences in the *strata* on the opposite sides of *veins*, in the *Hartz*, § 173, I.
———————————————— in the mines of *Freyberg*, § 437, I.
Masses of *quartz* containing *veins* of *black iron ore* scattered in vales in the *Fichtelberg* mountains, §§ 696, 705, II.

** *Veins composed of different substances.*

Veins of white *quartz* in a fibrous *schistus*, at *Zierenberg*, § 233, I.
——— of *trapp* in *sienite*, in the *Plauen-grund*, § 426, I.

Veins of *trapp* in *granite*, in the side of the small *Schneegrube*, § 522, II.

Surprizingly large *vein* of *agate* in *gneiss*, near *Maxen*, where a subsidence having taken place between two fractures, the vein is now seen to pass across the bed of a brook, §§ 455—457, II.

X.

Beds of *Coal* and *Surturbrandt*, which are both shewn to have proceeded from *peat-mosses* sunk beneath the level of the *ancient sea*.

Coal-pits, near *Aix-la-Chapelle*, §§ 248—254, I.
——— in the hills near *Rehburg*, §§ 334, 335, 338, I.
——— at *Osterwald*, §§ 359—361, I.
Bed of coal, in the valley of *Tharand*, § 427, I.
——— in a valley at the foot of the *Ertz-gebürge*, over some parts of which a stratum of *gneiss*, has slipped, § 767, II.
Upper stratum of *coal* at *Osterwald* resembling *surturbrandt*, § 360, I.
Beds of *surturbrandt* in the mountain of *Cattenbül*, §§ 196, 198, 199, 201, 206, I.
——— in *Mount Meisner*, §§ 211—214, I.
——— in the *Robelsberg*, §§ 217, 218, I.
——— in the neighbouring countries, § 234, I.
——— near *Helmstedt*, § 370, I.

XI.

The *disordered state* of the *strata* is seen in *Quarries*.

Quarry of *granite* near *Hernhutte*, § 482, II.
——— of *gneiss* near *Freyberg*, § 450, I.
——— of *lime-stone* near *Rudersdorf*, §§ 414, 415, I.
——— of *sand-stone* in the *Cattenbül*, § 197, I.
————————— in a hill near *Rehburg*, §§ 335—338, I.
————————— near *Bayreuth*, § 644, II.

XII.

Caverns are proved to have resulted from the ***unequal internal*** *subsidence* of the *strata*, while still under the waters of the sea.

Cavern near the issue of the *Bied*, §§ 37—41, I.
Grotto on the course of a brook near the *Elbe*, §§ 472, 473, II.
Caverns in *Bayreuth*, §§ 655—662, 664—670, II.
Level of the *ancient sea* at a particular period shewn by the *sea-sand* and *bones* of *white bears* found in these *caverns*, §§ 657, 658, 661, II.
Cavern in the *Ochsen-kopf*, § 702, II.

XIII.

Subterranean streams, formed within the bosom of the mountains, and issuing forth at the bottom of some of the neighbouring vallies.

Issue of the *Reuse* at *St. Sulpi*, §§ 2—4, I.
—— of the *Bied* above *Motier-Travers*, § 36, .

Issue of a stream which joins the *Reuss*, § 46, I.

—— of the *Noiraigue*, §§ 47, 75, 77, I.

—— of a brook supposed to be the discharge of the waters of the vale of *Locle*, §§ 67, 72, 73, I.

—— of four rivulets which unite to form the *Longe-aigue*, § 80, I.

—— of rivulets flowing to join the *Suze*, §§ 119, 120, I.

———— in the *Val-de-Tavanne*, § 122, I.

Discharge of the waters of the Lake of *Etalières* which has been produced by a recent subsidence, §§ 60—63, I.

———— of a brook at *Brevine*, § 63 *a*, I.

Intermittent torrent of *St. Martin*, §§ 99—102, 104, I.

Tunnels on the course of that torrent into which the water sinks, § 101, I.

—— in the *Val-de-la-Sagne*, § 77, I.

—— near *Chaux-de-Fond*, §§ 103, 104, I.

—— in the *gypseous* hill of *Osterode*, § 355, I.

Stream, at *Chaux-de-Fond*, which issues from one tunnel, and flows into another, §§ 107—113, I.

Two natural *wells* in which the water rises and falls, in the *Val-de-Travers*, § 82, I.

Proofs of the *subsidence* of the fractured *strata* into *Caverns* filled with air and water, the compression of which by the descending masses produced *explosions* on the bed of the ancient sea, XIV—XVI.

XIV.

The *blocks* of *stone* now scattered on our continents are demonstrated by their various phenomena, not to have *migrated* in any manner on the surface, but to be fragments

of

of the shattered *strata*, which were expelled from within during the catastrophes.

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* *Blocks of natures extraneous to the strata on which they lie.*

Blocks of *primordial stones* mixed with others of *lime-stone*, on the original slopes of the *calcareous* chain of the *Jura*, §§ 31, 42, 46, 50, 53, 102, 114, 121, I.

———————— in a stratum of *white clay*, which lies beneath a bed of *surturbrandt*, in the *Meisner*, this bed being covered by a stratum of *sand-stone* overspread with *basaltic* rubbish, § 211, I.

———————— to a great depth in the *sand*, near *Aix-la-Chapelle*, §§ 248, 254, I.

———————— very abundant in the *sandy* soil of *Bremen*, §§ 274—285, 287—290, 293, 301, 305, 312, 316, 318, 319, 321, 332, I.

———————— in such quantities as to form a superficial stratum on a hill of *marl-stone* near *Ilsenburg*, §§ 390, 391, I.

———————— in *sandy* soil in *Brandeburg*, §§ 409, 414, 417, I. §§ 597, 599, 601, 602, II.

———————— near *Dresden*, § 451, I.

———————— in the *sandy* plains near the *granitic* chain of the *Giant's mountains*, but very different in species from the strata of that chain, § 487, II.

———————— in *sand*, near *Sprottau*, § 586, II.

———————— intermixed with a great variety of others, on different soils in *Bohemia*, §§ 727, 730, 732—736, 749, 752, 754, 755, 757—760, 769, 777, 780, II.

———————— on *sand-stone*, near the *Elbe*, § 802, II.

——— of *granite* and *sienite*, in *heath-sand*, near *Darmstadt*, §§ 236, 240, I.

———————— in *sand*, in the country of *Brunswick*, §§ 368, 400—402, I.

Blocks of *granite* in the *Hartz*, of a *species* different from the *granitic strata* of that chain, §§ 378, 379, 386, I.

——————— and *white quartz*, near *Herrnhutte*, where no strata of the latter appear, §§ 482, 483, 485, II.

Blocks of *granite* and *white quartz* on a hill of *gneis*, near the *Bober*, § 575, II.

——————— on *argillaceous schistus*, near the *Bober*, § 582, II.

——————— on the *schistose* ridges of the *Fichtelberg*, § 696, II.

——————— on the slope of the *Ochsen-kopf*, but different from the *granite* of the mountain, § 703, II.

——— of *white quartz* on various soils in *Saxony*, §§ 614, 621, 622, 627, 628, II.

————————— in the country of *Bayreuth*, §§ 630, 632, II.

——————— containing *veins* of black *iron ore*, in vales on the opposite sides of the *granitic* chain of the *Fichtelberg*, §§ 696, 705, II.

——— of a *brown quartzeous stone*, on *sandy* soils, between *Leipzig* and *Zeitz*, §§ 612—615, II.

——— of *granulated quartz*, on *granitic sand* covering strata of *schistus* and *grey wacke*, in the *Hartz*, §§ 174—176, I.

————————— and very hard *sand-stone*, on hills of *lime-stone* and *sand-stone*, in *Hesse*, §§ 195, 220, I.

————————— dispersed over a very extensive tract of country in which no strata of this stone appear, except in rocks near *Aix-la-Chapelle*, § 260, I.

————————— near *Helmstedt*, §§ 369, 374, I.

——— of a *hard sand-stone*, on strata of *sand* of a different nature intermixed with *blocks* of *granite*, in the country of *Hanover*, §§ 163—165, 334, 339, 358, 359, 366, I.

————————— in *Hesse*, §§ 197, 207, 209, I.

——— of a stone composed of black *hornblende* and red *feldspar*, near *Potsdam*, § 600, 838—843, II.

——— of a hard *lime-stone*, extraneous to the strata, in the country of *Hanover*, §§ 166—170, 190, 363, I.

Blocks of a *sand-stone* unequally decomposed, near *Brunswick*, § 368, I.
—— of *grün-stein*, on the opposite sides of the *Fichtelberg*, §§ 693, 706, 727, II.
Prisms of *rock-crystal* among *blocks* of *primordial stones*, on the summit of the *Chaumont*, § 137, I.

** *Blocks of primordial stones not scattered in quantities proportional to their distance from the mountains whence they have been supposed to proceed.*

Abundance of *primordial blocks* in *Franche-comté*, on the side of the *Jura* farthest from the *Alps*, §§ 23, 27, I.
Tracts of country near the *granitic* chain of the *Hartz*, in which scarcely any *granitic blocks* are found, §§ 170, 342, 343, 346, 356, 368, 378, 390, I.
Vast abundance of *blocks* in the *peninsula* of *Bremen*, at a distance from any mountain, §§ 274—285, 287, 316, 332, I.
Large *blocks* of *granite*, near *Bergstrass*, separated by several ridges of hills from the *Giant's mountains*, § 485, II.
Tract of ground, near the *Fichtelberg*, where no *blocks* of *granite* are found, § 646, II.

*** *Spaces covered with blocks alternating with other spaces in which none appear.*

Near *Osnaburg*, §§ 151—153, 155, I.
Near *Hanover*, §§ 159, 160, 341, 342, I.
In *Bremen*, §§ 284, 288—290, 321, I.
Near *Wolfenbüttel*, §§ 398, 399, I.
Near *Brunswick*, §§ 399—402, I.
Near the *Oder*, §§ 587, 595, II.
In *Saxony*, §§ 602, 609, 837, II.

**** *Blocks on eminences, which they cannot have ascended by any cause, since those eminences have been at their present relative level.*

In the *Jura*, §§ 34, 35, 43, 49, 91, 128, 137, I.
In the *Hartz*, §§ 174, 175, I.
On the *Tafelfichte*, §§ 489, 490, II.
On the *Luchsberg*, §§ 721, 722, II.

***** *Eminences composed of Blocks.*

Promontory in the *Jura*, § 96, I.
Many eminences in the *Hartz*, §§ 175, 177, I.
The *Ilsenstein*, §§ 394, 395, I.
The *Borsberg*, §§ 452, 453, I.
Summit of the *Nelken-stein*, § 570, II.
——— of the *Ochsen-kopf*, §§ 698, 700—702, II.
——— of the *Schnee-berg*, § 701, II.
Promontory advancing from the *Luchsberg*, § 719, II.

****** *Blocks shewn not to have been brought down from the mountains by streams.*

Blocks on the bed of the *Reuse*, § 37, I.
——— on the course of the rivers proceeding from the *Hartz*, §§ 397, 398, I.
——————————————— from the *Giant's mountains*, §§ 495, 496, 506—511, 515, 539—541, 543, 554, 557, 562—565, 575, 577, II.
——————————————— from the *Fichtelberg*, §§ 688, 689, 717, II.

******* *Rounded Blocks reduced to their present form by the decomposition of their angles, and not by the action of running waters.*

In the *Val de Rus*, §§ 93, 95—99, 102, I.

On the bed and sides of the *Zackel*, §§ 506—510, 540, 554, II.

——————— of a brook which joins that river, § 514, II.

——————— of the *Little Zackel*, § 515, II.

On the *Giant's mountains*, §§ 542, 543, 549, 551, II.

On the bed and sides of the *Bober*, §§ 555, 557, 559, 562—565, 567, 572, II.

In the valley of *Walterdorf*, § 579, II.

******** *Phenomena which indicate the expulsion of the Blocks from within.*

Situations of some of the *blocks* on the *Jura*, §§ 34, 50, 52, 79, 91, 128, 130, 137, 138, 140, I.

Cavity which has its sides covered with *blocks*, and appears to have been the focus of their *explosion*, near *Osnaburg*, §§ 154, 155, I.

——————— near *Zarrendorf*, § 156, I.

Cavities of the same kind in *Bremen*, § 284, I.

——————— near *Lunenburg*, § 322, I.

A low space near *Weissenheid*, bearing similar characters, § 713, II.

Blocks which, having been thrown up by *explosion*, were broken in their fall, on the *Chaumont*, § 137, I.

The same phenomenon, on a slope on the bank of the *Reuse*, § 140, I.

——————— in *Bremen*, § 289, I.

XV.

The *stony strata* are frequently covered with a *loose superficial soil extraneous to their nature.*

Loose soil containing *blocks* and *gravel* of *white quartz* and *grey wacke,* on *schistose* hills in *Saxony,* §§ 621—623, 627, II.

———— produced by the trituration of masses of strata during the catastrophes, and covering the *schistose* ridges which border the *Fichtelberg,* §§ 693, 695, II.

———— of *sand* and *granitic rubbish* on *sand-stone* in *Bohemia* § 755, II.

XVI.

The *Gravel* contained in the *superficial* soil is composed either of *fragments* of *stony strata,* expelled, like the *blocks,* from within, or of *silices,* formed in *calcareous strata* which were *dissolved* while still covered by the *ancient sea.*

* *Gravel composed of fragments of stony strata.*

Of *primordial stones* on the bed of the *Eder,* and in the soil of the neighbouring hills, §§ 224, 225, 228, I.

———————— mixed with a great variety of *marine exuviæ,* which shew it to have existed in the form of gravel on the bed of the *ancient sea,* near *Aix-la-Chapelle,* § 256, I.

———————— and other stones, in the country of *Hanover,* §§ 357, 364, I.

———————————————— near *Helmstedt,* § 366, I.

Of *white quartz,* on the beds of streams in *Saxony,* and in the soil of the neighbouring hills, §§ 613, 628, II.

Rounded fragments of the *kiesel-schiefer,* or *touch-stone,* on the bed of a brook, and in the loose soil of a valley, of the *Hartz,* § 356, I.

** *Siliceous Gravel.*

Flints containing *marine bodies* and *chalk*, in the *sand*, in the country of *Hanover*, §§ 155, 156, 158, 341, I.
—— abounding in the *sand*, throughout a very extensive tract in which no *chalk* appears, except in a hill near *Aix-la-Chapelle*, § 261, I.
Soil, near *Calais*, composed of *siliceous gravel* differing entirely in its nature from the *flints* contained in the *chalk* of the neighbouring cliffs, § 269, I.
Siliceous gravel in *Bremen*, § 289, I.
———— near *Dresden*, § 431, I.
Flints intermixed with masses of *amber*, in the *sand*, near the *Giant's mountains*, § 487, II.

XVII.

Phenomena which indicate the existence of *ancient Volcanoes.*

* *Basalts, which were probably produced by Lavas bursting forth on the bed of the ancient sea.*

Basalts in the form of *polyedrical wedges* containing *balls*, on the *Dransberg*, §§ 193 *a*, 194, I.
The same on the *Cattenbül*, § 200, I.
———— on the *Meisner*, §§ 209—213, I.
———— on the *Robelsberg*, §§ 217, 218, I.
———— on mountains near *Cassel*, §§ 221, 222, I.
———— on various hills in *Hesse*, §§ 226, 229, I.
Rock of *basaltic prisms* on the summit of the *Spitzberg*, § 479, II.
A hill rising from the same base composed of *spherical basaltic masses*, each containing many *balls*, § 480, II.
Stratum of *basaltic balls* on one side of the *granitic* hill of *Herrnhutte*, § 482, II.

Basaltic balls scattered over a horizontal tract near *Töpliz,* §§ 769, 770, II.

Regular arrangement of *basalts* in hills bordering the *Rhine,* § 247, I.

———————————— near the *Elbe,* §§ 775, 781, II.

Association of regular *basalts* with rocks of the same stone irregularly fractured in the hill of *Stolpen,* § 476, II.

Basalts containing *olivin* on the *granitic* hill of *Hertzberg,* § 497, II.

——— in *strata* on the skirts of the *Giant's mountains,* § 500, II.

——— on a hill above the *Welt-ende,* § 559, II.

——— on the summits of mounts belonging to the *Fichtelberg,* § 724, II.

———————— of eminences near the *Eger,* § 728, II.

Basaltic mount, near *Langwasser,* § 499, II.

——————— near the *Bober,* § 578, II.

——— *cones,* in *Bohemia,* §§ 750—753, 764, II.

——— summits of some of the *gneiss* mountains of the *Ertzgebürge,* § 768, II.

——— fragments scattered in *Bohemia,* § 734, II.

—————— in *strata* alternating with others of *clay,* in the *Cammer-hügel,* in which there is a cavity evidently produced by internal fire, §§ 731, 732, II.

** *Remains of sunken Volcanic Cones.*

On a hill near *Göttingen,* 192, 193 *a,* 06, I.

At *Cassel,* §§ 222, 223, I.

Near *Darmstadt,* §§ 239, 240, 242, I.

SECOND PERIOD,

Which is still continuing, and which commenced at the epoch when our *continents*, being *abandoned* by the *sea*, became subject to the action of *atmospherical causes*.

XVIII.

Since *Rivers* began to flow, they have carried on various operations on their *banks* and *beds*.

* *The loose soil washed away by streams, in clearing their channels, and the blocks and gravels originally contained in it left uncovered on their beds.*

Primordial stones left uncovered on the bed of the *Reuse*, § 37, I.
Blocks on the bed of a brook near *Cassel*, § 221, I.
Gravel on the bed of the *Eder*, §§ 224, 225, I.
Blocks on the bed of the *Ecker*, § 396, I.
Rounded granitic blocks on the bed of the *Little Zackel*, § 515, II.
———————————— of the *Bober*, §§ 564, 567, II.
Gravel on the bed of some rivulets in *Saxony*, §§ 609, 628, II.
——————— of the *Elster*, §§ 613, 619, II.
Stones on the bed of the *Red Mayn*, §§ 688, 694, II.
——— and gravels on the bed of the *Elbe*, §§ 778, 807, 819, 821, 830, 833, 835, II.

** *Rounded blocks impelled by some rivers along the narrow and rapid parts of their beds, but left stationary on the wide and horizontal parts.*

Shewn on the bed of the *Schwartzbach*, § 496, II.
——————— of the *Zackel*, §§ 506—509, 539, 540, 554, II.
——————— of the *Kockel*, § 518, II.
——————— of the *Bober*, §§ 554, 564, 565, 567, II.

*** *Operations of Rivers in attacking their banks.*

Of the *Elbe*, §§ 301, 310, 324, 326, 327, 403, 405, I. §§ 802, 805, 817, 822, 835, II.
Of the *Weser*, § 366, I.
Of the *Bober*, §§ 564, 574, 576, II.
Of the *Oder*, § 593, II.
Of the *Elster*, § 620, II.
Of the *Red Mayn*, § 686, II.
Of the *Rösla*, § 728, II.
Of the *Eger*, § 742, II.
Of a rivulet flowing in a combe near *Brix*, § 762, II.
Of a brook which falls into the *Elbe*, § 812, II.

**** *In forming beaches and strands at the foot of their crumbling sides, which are thus preserved from farther demolition.*

Beach formed by the *Oder*, § 593, II.
——————— by the *Red Mayn*, §§ 686, 687, II.
Beaches and *strands* formed by the *Elbe*, §§ 804, 805, 817, 825, 827, 835, 836, II.

***** *In*

***** *In forming alluvial grounds, which narrow their channels.*

Alluvial soils formed by the *Rhine* and the *Moselle*, § 246. I.
——— and islands formed by the *Elbe*, §§ 298, 299, 302, 310, 312, 313, 315, 324, 327, 404—406, I. §§ 607, 780, 815, 817, 820, 821, 823—825, 833, 834, 836, II.
——— by the *Bober*, §§ 574, 590, II.
——— by the *Oder*, §§ 593, 596, II.

****** *In raising and levelling the bottom of their beds, and the low grounds which border them.*

Soils raised and levelled by the *Reuse*, §§ 37, 139, I.
——— by the *Ocker*, §§ 397, 398, I.
——— by the *Elbe*, § 406, I. §§ 607, 610, 792, 800, 805, 807, 817, 825, 827, 828, 836, II.
——— by rivulets which join the *Elbe*, § 461, II.
——— by the *Zaekel*, § 554, II.
——— by the *Bober*, §§ 554, 568, 574, 576 II.
——— by the *Oder*, § 596, II.
——— by the *Elster*, §§ 612, 619, 620, II.
——— by streams in *Bayreuth*, § 645, II.
——— by the *Wiesent*, § 679, II.
——— by the *Red Mayn*, § 694, II.
——— by the *Eger* and its branches, §§ 732, 736, II.
——— by the *Biela*, § 771, II.

XXVI.

Chronometers resulting from the *progress* of *agriculture* and *human labour.*

Demolition of rocks near *Rehburg*, § 333, I.
Names of places, in some parts of *Germany*, indicative of the period when lands were first taken into cultivation, § 374, I. § 643, II.
Commencement of cultivation on lands abandoned by the *Bober*, § 574, II.
Progress of cultivation on hills bordering the *Oder*, § 594, II.
———————— on slopes near the *Elbe*, § 814, II.
Artificial formation of *alluvial soils*, § 820, II.

THE END.

Law and Gilbert, Printers, St. John's Square, London.

Lake of *Weissenstadt*, §§ 710, 716, II.

Pools on the courses of the streams descending from the *Giant's mountains*, §§ 498, 543, 547, 553, II.

——— below the *Schnee-grübe*, § 621, II.

Pool on the course of a rivulet in *Saxony*, § 609, II.

Pools on the course of the branches of the *Mayn*, § 642, II.

——————— of the *Eger*, § 717, II.

——————— of the *Naab*, § 725, II.

Small *ponds* and *marshy spaces* in the valley of the *Wiesent*, § 679, II.

⁂ Open horizontal spaces, in which, as in Lakes, Rivers have deposited whatever materials they have collected in their course.

On the course of the *Doux*, §§ 105, 107, I.

——————— of the *Reuse*, § 139, I.

——————— of the *Ocker*, §§ 397, 398, I.

——————— of the *Elbe*, § 403, I. §§ 773, 780, 804, II.

——————— of the *Bober*, §§ 554, 564, 566, 568, II.

——————— of the *White Mayn*, §§ 637, 638, II.

——————— of the *Töpel*, § 745, II.

XXI.

Phenomena of *Peat*.

Peat-moss in the *Val de la Sagne*, §§ 75, 76, I.

Peat formed, near *Dunkirk*, on a soil consisting of *sea-sand* which contains *recent shells*, § 267, I.

Peat-moors in the country of *Bremen*, §§ 277, 278, 315, I.

——————— near *Lunenburgh*, § 323, I.

Peat-moors in the country of *Hanover*, §§ 340, 341, I.
Peat filling up the *Fichtel-see*, § 699, II.
—— on one side of the *Ochsen-kopf*, § 703, II.
Peat-moor in which the Lake of *Weissenstadt* is situated, § 71[illegible] II.
———— from which the *Black Elster* issues, § 835, II.

The actions of *running waters*, of *atmospherical causes*, and of *gravity*, afford, by their *progress*, a variety of *Chronometers*, manifestly indicating that our *continents*, on which these actions have been exercised, cannot be of any higher *antiquity* than is asserted in the MOSAIC HISTORY. XXII.—XXVI.

XXII.

Chronometers afforded by the *decomposition* of various kinds of *stone*.

* *Masses rounded by the decomposition of their angles.*

Masses *rounded*, while still remaining in their original situation in a *granitic* rock, near *Darmstadt*, § 239, I.
Rounded granitic blocks in the country of *Bremen*, §§ 282, 285, I.
Columnar piles of *rounded blocks* of *sand-stone*, near the *Elbe*, §§ 466—467, II.
—————————— of *granite*, in the *Giant's mountains*, §§ 510, 516, 517, 551, 552, II.
Rounded blocks of *sand-stone* on the course of the *Bober*, § 580, II.